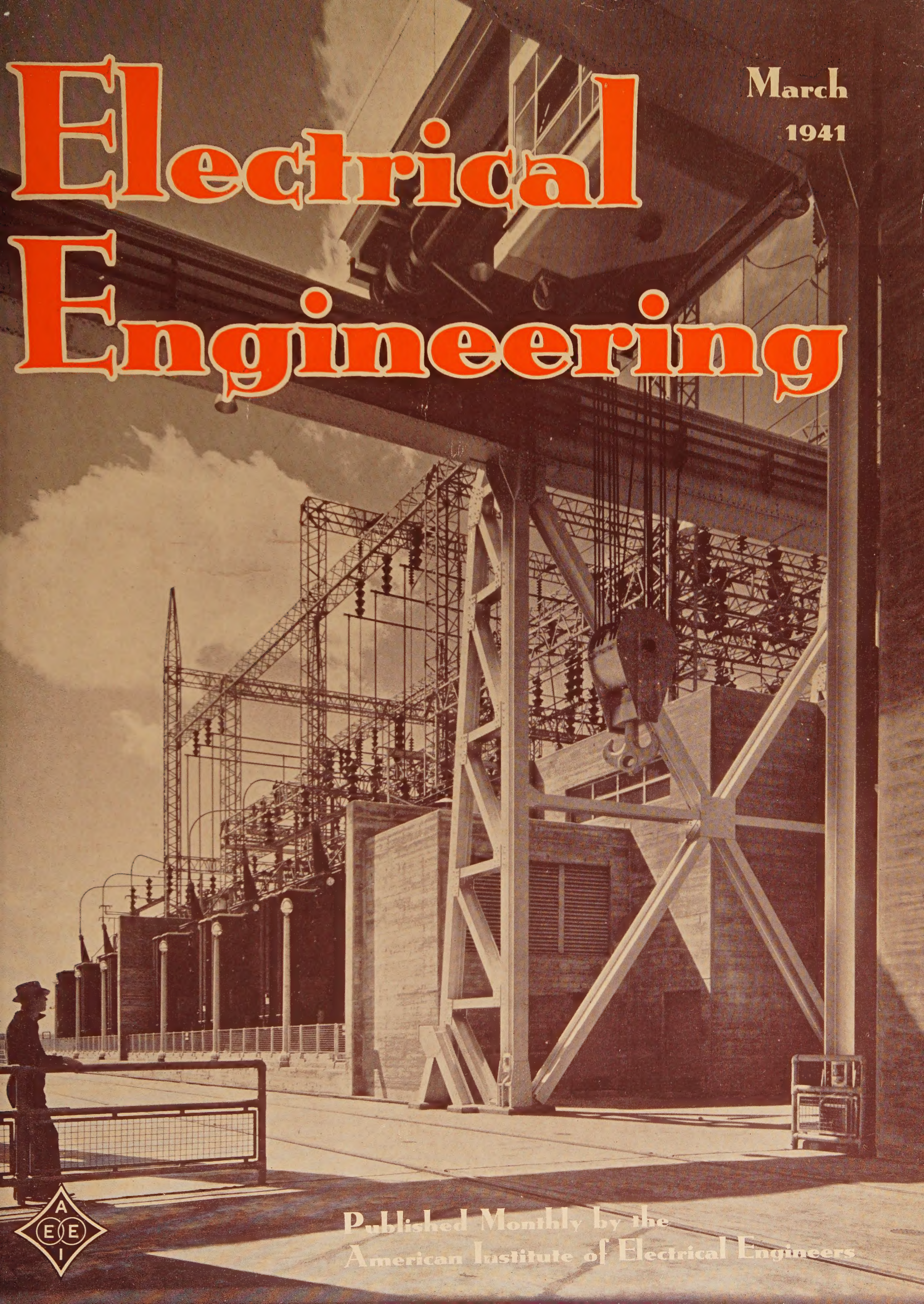
Electrical Engineering

March
1941



Published Monthly by the
American Institute of Electrical Engineers

To Measure LIGHT
ELECTRICALLY

Testing a 60-inch searchlight

MEASURING the 800,000,000 beam candlepower of a searchlight would certainly have been a headache in the days when light intensities were measured by means of a standard measuring candle and a grease spot on a piece of paper. Today this task, which requires a minimum of 100 separate measurements to explore the light intensity throughout the beam, is comparatively simple—thanks to the development of special electric measuring equipment.

In our Illuminating Laboratory, where the candlepower of searchlights, floodlights, and streetlights is measured, the photometric measuring device consists of a combination of light cells and a galvanometer.

When measuring beam candlepower, the light beam is directed upon a collecting device composed of light cells which convert light energy into an electric current. This current, which is directly proportional to the light intensity, is transmitted to a sensitive galvanometer, the scale of which is calibrated in foot-candles. Thus, it is possible to obtain quickly and accurately the many readings needed to determine the light-distribution pattern and the beam candlepower.

The light cell is also the basic element in several other G-E light-measuring instruments: the light meter, used to measure light intensities in homes, offices, and factories; the exposure meter, used in photography; and the luximeter, used primarily to determine the degree of pasteurization of milk.

These accurate, dependable instruments are typical of our complete line of equipment available for the measurement of all electrical quantities—available in dozens of styles, indicating and recording, and in ratings to fill every need. If you have a problem that involves measurement, let us help you solve it. General Electric, Schenectady, N. Y.

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

GENERAL ELECTRIC

602-19-6200

Electrical Engineering

Registered U. S. Patent Office

for March 1941—

The Cover: Part of the powerhouse area at the Pickwick Landing Dam of the Tennessee Valley Authority on the Tennessee River

Photo courtesy TVA

Transactions Section *(Follows EE page 148; a preprint of pages 89–136 of the 1941 volume)*

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High Lights • •

Total Defense. Characterizing the current world upheaval as but part of a long-term cycle of social revolution which is manifesting itself in one way in Europe and in other ways in America, President Charles E. Wilson of the General Electric Company told AIEE winter conventioners that prompt and definite action is required to preserve the American free-enterprise System—in fact the democratic way of life itself. On the basis of a realistic analysis, he submitted a step-by-step plan of possible action and challenged industrial leaders and thoughtful private citizens to take the initiative without delay—to "arise, or be forever fallen" (*pages 99–105*).

New Subway. If all subway and elevated railroad trackage in New York City were laid as single-track line, it would extend almost from New York to Chicago. Although the Sixth Avenue line which was completed in December 1940 comprises only $7^1/_2$ miles of track, a very small proportion of the total, its total cost was about $60,000,000. It is regarded as the most difficult piece of subway construction ever undertaken, and involved almost every type of construction method (*pages 110–20*).

Transformer Noise. The audio noise of transformers, which must be limited near inhabited districts, has been determined to arise from the change in dimensions produced in the core steel by the alternating magnetic flux. The basic noise may be increased by resonant vibration of mechanical parts. Theoretical relations for the sound produced have been derived and tested on commercial transformers (*Transactions pages 109–12*).

Driven-Ground Characteristics. Test data have been obtained on the impulse and 60-cycle characteristics of common rods driven in natural soil largely of clay composition; results have been analyzed in the characteristic curve of the ratio of impulse to 60-cycle resistance, for impulse currents representing conditions ranging from a traveling surge to direct strokes of lightning (*Transactions pages 123–8*).

Smaller Hollow-Pipe Lines. Relatively large transverse dimensions, comparable in magnitude to the wave length, are the chief disadvantage of the hollow-pipe type of conductor for ultrahigh-frequency electromagnetic energy; several cross-sectional shapes of smaller dimensions have been described, and the theory of one, the "septate coaxial cable" derived (*Transactions pages 119–22*).

Edison Medalist. A "pioneer among pioneers" is how George Ashley Campbell, 1940 Edison Medalist, is characterized by AIEE Past President Frank B. Jewett, his "associate and friend for more than 35 years" (*pages 106–09*).

Cable Transmission of Pictures. A new system of transmitting facsimile matter from London to New York by submarine cable was made available to the public in April 1939. Unique measures have been used to insure undistorted images and maximum speed within the limited frequency system available through the cable, and special networks and amplifiers have been developed (*Transactions pages 105–08*).

Automatic Aircraft Control. Developments have proceeded to the point where "with nominal additional development it will be possible, in the near future, to cause an airplane to take off, to continue in automatic flight on a predetermined course, and then to land automatically at a predetermined place, entirely without human control" (*pages 122–6*).

Initial Breakdown Voltage. An approach toward a more generally applicable theory for predetermining spark-over and corona starting voltages has been made by calculating initial breakdown voltage by means of formulas developed for two quantities characteristic of the gas in cases where the field, if nonuniform, verges toward the cathode (*Transactions pages 99–104*).

Lightning Protection. An analysis of trouble data showing the degree of protection afforded to medium-voltage lines by various values of insulation strength has been made by one company and the data used in selecting minimum insulation values on which to base improvement of its lines to reduce lightning trouble (*Transactions pages 128–32*).

Instability of Synchronous Machines. A general stability criterion has been developed, which considers the mutual interactions of hunting, self-excitation, and loss of synchronism, hitherto treated only as separate phenomena, and thus provides an analysis that indicates the limitations and proper fields of reference of the approximate formulas (*Transactions pages 116–19*).

Electric Strength of Air. An investigation has been made of the electric strength of air at pressures up to 21 atmospheres. Sparking voltages have been determined for air under pressure as measured with 60 cycle alternating voltage applied to sphere gaps, and deviations from the linear pressure-voltage relation that exists at low pressures noted (*Transactions pages 112–15*).

Automatic Printing Ammeter. A new instrument has been developed which will automatically read and record in numerals, at predetermined time intervals, the ampere loading on 50 different electric circuits (*Transactions pages 93–9*).

Standard Impulse Voltages. Culminating more than ten years' work by a joint committee composed partly of AIEE representatives, a standard series of basic impulse insulation levels has been adopted (*page 121*).

Television Standards. The 22 standards for commercial television proposed to the Federal Communications Commission by the National Television Systems Committee and scheduled for public hearing March 20 are presented in full in the "Current Interest" section of this issue (*pages 145–7*).

Power-System Governor. A new type of electrical control has been developed by which a standard power-system governor may be made sensitive to system load as well as to frequency, and which may be used without sacrifice of reliability (*Transactions pages 89–92*).

Breakdown Strength of Air and Freon. D-c breakdown studies in air and in Freon 12 at high pressures and in a uniform field have been extended to higher voltages; for air, to 1,000 kv, and for Freon to over 350 kv and to 135 pounds per square inch absolute (*Transactions pages 132–5*).

Bessel Function $I_n(x)$. Additional values for the modified Bessel function $I_n(x)$ have been computed, using the arguments 0.1, 0.2, 0.3, etc., and the enlarged five-figure table is presented (*Transactions pages 135–6*).

Coming Soon. Among special articles and technical papers currently in preparation for early publication are: an article describing recent applications of radio to the remote indication of meteorological elements by Harry Diamond; a paper on a new air circuit breaker with 250,000-kva interrupting capacity by R. C. Dickinson (A'37) and R. H. Nau (A'40); a paper on prime mover speed governors for interconnected systems by R. J. Caughey and J. B. McClure (A'29); a paper on engineering requirements for program transmission circuits by F. A. Cowan (M'29), R. G. McCurdy (F'34), and I. E. Lattimer (M'35); a paper on the service-factor rating of arc-welding generators and transformers by R. C. Freeman and A. U. Welch (A'36); a paper on system stability by F. W. Gay (F'32); a paper on a new method for introducing relaxed initial conditions to transient problems by W. C. Johnson (A'35); a paper on magnetic fields in watt-hour meters, dealing with the effects of wave form on the registration of single-phase watt-hour meters, by C. A. Keener (M'28), M. A. Faucett (M'35), and N. S. Helm; a paper on atmospheric variations and apparatus flashover by P. H. McAuley (A'36); a paper on secondary networks to serve industrial plants by C. A. Powel (M'20) and H. G. Barnett (A'33); a paper on corrosion problems relating to the water-cooled steel-tank power rectifier by A. J. Renscheid; a paper describing the Varioplex, a new development in telegraphy, by E. R. Shute (M'17); a paper on arc-backs in ignitrons in series by J. Slepian (F'27) and W. E. Pakala (A'38); and a paper describing an electron microscope for practical laboratory service by V. K. Zworykin (M'22), J. Hillier, and A. W. Vance.

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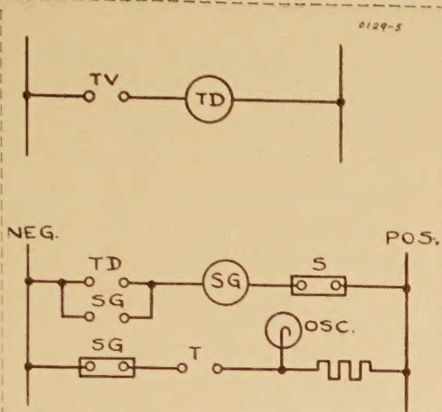
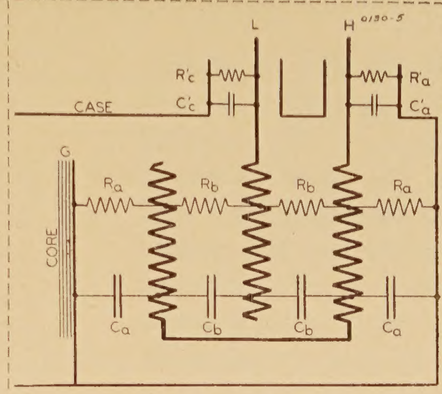
CORRECTION

To correct a printing error in your January issue involving the interchange of figures 5 on pages 25 and 29 of the TRANSACTIONS section, these gummed paste-overs are supplied. Just separate the items below and mount as noted.

This is figure 5 for page 25

This is figure 5 for page 29





hat comes varied ex- comes of outh, and s of con- r. Wilson vey of a e to every ocracy.

cing challenging discussion and action, comes from one of America's youngest and foremost industrial leaders—a man who came to the top "the hard way" in the highly competitive American free-enterprise system for which he here seeks a means of preservation. The "Letters to the Editor" columns are open for discussion of this timely topic.

received as an effort to serve the land and the institutions we all love so much.

Now, certainly in these critical and confusing times, a clear conception of the character and significance of the world conflict is essential, for, obviously, if we are to proceed to the development of a program which will contribute to our "total security"—total security on our moral, physical, and economic sectors—we must start from a realistic premise. And proceed we must, promptly, in the development of such a program.

In truth, "it is later than we think"; and chaos can be the consequence of confusion and procrastination.

In the course of this presentation I may seem, at times, to express some thoughts which might be interpreted as a criticism of industry. Therefore, at the outset, I should like to establish understanding on that point. My whole career has been in industry, and, fortunately, the character of that career has been such that I have been brought into intimate association with almost every form of industrial and commercial enterprise. Out of these associations there has grown a tremendous pride in the accomplishments of industry, as well as an intense admiration and respect for the progressive citizens who, in the preponderant majority, compose it—the conscientious citizens in the shops and offices, in the drafting rooms, and in positions of management of every degree and kind, who, operating as organizations in enlightened enterprises, have given employment and enjoyment to millions of people while providing America with the highest degree of economic security and the highest standard of living in the world. Therefore, in anything which I may later say which seems to suggest shortcomings, I hope you will see in my comments not a presumptuous inclination to criticize, but, instead, a positive indication of my infinite confidence in the ability of industry to do an even better job in the building of an ever-better America; a confidence which is coupled with a driving desire to have industry, as an integrated entity, go forward faster and more fruitfully than it ever has before.

WILL BE NO "RETURN TO NORMAL"

Having given you that assurance, I shall now proceed to outline my conception of the true character of the world conflict—with one intervening assertion. This is that, in order to save you time, I shall speak rather emphatically, assured that you will accept my words for what they really are: Words which are merely the earnest expression of the convictions of some of your fellow-citizens who are concerned, above all else, with their country's welfare; the carefully considered words of fellow-countrymen of yours who seek the collaboration of the splendid minds

An address delivered January 29, at the 1941 AIEE winter convention, Philadelphia, Pa.

which comprise this body in finding the most effective means of preserving individual initiative and private enterprise as the mainstays of our economic life.

What, then, is the true state of the world as I see it? It is this:

The world is immersed in more than a war of historically conventional character. Our own beloved nation is involved in more than a "temporary emergency" from which, after a few years, it will emerge and return to "normal" living in a "peaceful" world; a world made "peaceful" by the fact that some "national leaders" had gained military ascendancy over others and had thus forced the signing of some papers. In the critical circumstances confronting the world in general, and our country in particular, failure to recognize these facts is not only unrealistic but dangerous.

Instead, there must be a complete, realistic comprehension of the fact that the world—our nation included—is passing through what history may later record as the second stage of a revolutionary movement of the masses; a movement born during World War I and likely to last, with intermittent armistices of one kind or another, for two or three decades more. We must fully realize that this is a movement based upon a sense of frustration—an emotional manifestation frequently approaching unreasoning, sacrificial hysteria—and we must see that, as such, it can be turned to a course of reason only by reasonable and sacrificial actions of a character which appeal to the emotions and the aspirations of the masses more than do the actions and the appeals to which they are now responding.

Today the practical controlling fact is that hundreds of millions of people throughout the world have been persuaded, to the point of evangelistic conviction, that the capitalistic system is the cause of the economic insecurity of the common man and that, as the root of his economic ills, this system must be drastically modified, or failing that, destroyed.

TOTALITARIAN LEADERS ARE BUT SYMBOLS

Recognition of the revolutionary character of this world-conflict will lead also to a fuller realization of the fact that current "totalitarian" leaders are but symbols of this movement. Further, from this realistic point of view, it will be seen that, notwithstanding the ruthless force exercised by these leaders in beating the more mature segments of their peoples into a state of resentful spiritual resistance, there is abundant evidence that they are strongly sustained as symbols by a preponderant majority of the people under 40 years of age. These are the newer generations, born and bred and ideologically conditioned under the almost exclusive influence of the "new" leaders. They are the generations which, after willingly sacrificing their political freedom, are now sacrificing their lives; and they make these sacrifices willingly because they sincerely believe that, through these leaders, a better and broader form of economic freedom will be gained, either for themselves if they survive, or for succeeding generations if they pay the supreme sacrifice.

This realistic point of view also leads to the sad conclusion that should these symbols meet the disaster or the death so widely and so earnestly wished upon them, this revolutionary movement most probably would suffer no more than temporary confusion while substitute symbols were being elevated to leadership. Further, it suggests that such an eventuality might lead more easily to chaos than to a return to conventionality.

PEOPLES SEEK ECONOMIC FREEDOM AND SECURITY

But as a world movement, the scope of this conflict extends beyond the sphere of these symbols. In the Central and South American countries, manifestations of it have been and continue to be common; and this is equally true of many parts of the British Empire. Although the war aims of England have not been officially expressed, public speeches, parliamentary debates, the prominence given labor leaders, and many other indications of public sentiment supply ample evidence of the ambition of the British people. From this evidence, it may clearly be seen that the ardent aim of the millions of heroic common people in Britain—first to defend themselves against the dictators, and finally to destroy them—arises basically from the deep-held desire to insure for their masses and for their fellowmen in other lands a much larger measure of economic freedom and security than the conventional capitalistic and imperialistic system has previously provided. True it is, of course, that they treasure the democratic tradition, but let us be sure to see that they insist upon its preservation in an atmosphere of economic freedom for all.

Therefore, while political freedom happily has been preserved in the British Isles, in its associates in the Commonwealth, and in the United States, it is important to remember that in these countries many economic controls willingly have been granted to government by the masses of the people in exchange for promises and for performances serving the mass revolutionary aim: More economic freedom and security. Hence, although in the United States, so far, we have had no more than an acceleration of the *evolutionary* process—rather than the *revolutionary* process—it should be borne in mind that the aim of the majority of the American people, as evidenced by their insistence that this acceleration continue, has been substantially that of the revolutionaries. Further, it should be remembered that in the last national election both presidential candidates, recognizing the aspirations of this majority and realizing that this was a mass movement overshadowing all partisan considerations, pledged their efforts to an enlargement of economic security for ever larger stratas of society; and that these candidates differed only regarding the manner in which this aim might best be attained.

CHALLENGE TO FREE-ENTERPRISE SYSTEM

Now, if you believe as strongly as I do that this is a realistic appraisal of the aspirations and the forces underlying the conflicts and confusions abroad in the world today—the conflicts and confusions which have brought civilization almost to the brink of chaos—your natural

questions will be those with which I struggled; such questions as:

——What more can the free-enterprise system do, in the face of this world revolutionary movement; a movement heretofore unmatched, either in extent, or in emotional intensity, or in destructive potentialities?

——How, in the midst of this dynamic world disorder, shall the capitalistic system—or what we in the United States call the American free-enterprise system (which, parenthetically, I should like to call the capitalistic system in its most constructive form)—be sustained in its most useful form; the form in which it can be the primary provider of economic security for all of the people at all times—in times of peace and plenty, in times of depression, in times of national emergency, and in times of war?

——How may an ever broadening bulwark of public faith be built to protect this free-enterprise system, seeking to serve this purpose, against its communistic and totalitarian enemies?

——How may we control and conquer the causes of suspicion and condemnation which too often create breaches in this bulwark of public faith upon which the protection of the system depends?

Basically, the answers to these questions seem simple; practically, the solution of the problems they present is most difficult.

The simple answer seems to be that again, and again, and again the financial and managerial components of our free-enterprise system must prove by deeds as well as by words their full comprehension of their social responsibilities (their deep sense of public service) and their unmatched capacity to positively plan, to put into effect, and to police a program of industrial and commercial progress acceptable to the majority of our people; people whose economic security and destiny are vitally affected by the decisions of these controlling components of the system. In the circumstances surrounding us today, who will doubt that this action must be prompt and positive, and of a character which will demonstrate beyond the chance of successful challenge that the public-spirited people administering private enterprise inherently and actually excel the people comprising political organizations (no matter how sincere the intentions of the latter may be) as instrumentalities for insuring an ever-increasing measure of economic freedom and security for all of the people (save the indolent) all of the time?

MORAL SECURITY IS FIRST DEFENSE

Never before has the American free-enterprise system been confronted by such a serious challenge. And never before has there been—and perhaps never again will there be—such an opportunity, or such an obligation, to prove the full worth of this system as an efficient, economical, and trustworthy servant of society. Moreover, in these dark days we may be sure that as the American free-enterprise system sees this enlarged opportunity, as it assumes this greater obligation, and as it proves still more fully its worthiness, it will re-establish emotional bonds of mutual regard and respect between all elements of our economy; the bonds of national unity which will serve as a firm foundation for our *moral* security, the first fortification of our political and economic freedom.

Happily, it may be stated as a fact that this first fortification is rapidly rising; and, that being true, the comforting consequence is that behind it there is rising with equal rapidity the vast and varied reservoir of materials required for our *physical* security. For that physical security, our immediate necessities have been stated repeatedly and comprehensively by our Commander-in-Chief, and by those drawn from management, labor, and government upon whom he has placed the responsibility of organizing, co-ordinating, and leading our immense industrial resources to the end that our nation may be in fact—and on time—the "arsenal of democracy." Therefore, on the subject of our necessities for physical security, let it be enough for me to say here that everything I have said hereinbefore has had as one of its most important aims the lending of emphasis to the urgency of meeting our *physical* needs, as well as our *moral* needs, for national security. Further, I hope that I have helped to make clearer the fact that these physical needs are so frightfully pressing that absolutely nothing else—no other conceivable consideration—can possibly be important enough to justify the slightest interference with maximum progress in the provision of these materials to the full extent of industry's total capacity.

DEMOCRACY'S DELIBERATIVE PROCESSES

For my part, I am sure that enlightened industry in every part of our land is fully conscious of that fact; and I am equally certain that it is proud of the additional fact that its experience, its skills, and its forms of organization place it in a front-line position to provide most of the materials needed in this great emergency. That being true, no one need doubt that industry will do its full patriotic duty; and no one need fear that, in the performance of this duty, it will fail to employ every resource required for the provision of the materials needed for our nation's physical security just as fast as human ingenuity and an intense desire to serve makes possible—and that I'm sure will be awfully fast for, after all, we are Americans.

However, as we proudly remember that we are Americans "capable of performing production miracles," let us not forget that the deliberative processes of democracy are inherently slow in arriving at decisions, particularly in times of crisis; and that much of the defense delay which distresses our nation today is caused by the very processes which we are preparing to defend. This is said not to criticize the democratic process—for that I hold to be the greatest form of free government that man ever devised; but I do say that, as a nation, we must place the principal responsibility for deferred and indecisive action where it belongs: upon the whole people, whose reactions and aims are so very slowly reflected through the democratic deliberations of their chosen representatives.

To this I also may add that many of the delays within industry itself probably may be traced to the fact that the democratic deliberative process is a practice common also in the determination of decisions within the institutions of enlightened enterprise.

PHYSICAL SECURITY IS PARAMOUNT

Now, for continental physical security, the relative order of urgency seems to be first the provision of materials

and the training of men for the Navy, for the Air Corps, and for the Army, closely followed by the need for enlarged reserves in our power and transportation facilities. In the broader and more realistic sense, we may see that defense materials for Britain, or for any other nation combating the supporters of the philosophy of force, are in fact an integral part of our own national defense. Here again the realistic view will clearly reveal that, as a nation, we now must be prepared to pay *any price* for the time that we have lost and for the time that we require actually to provide our own national and hemispheric defense. Taking that view, we shall see that so long as any aid we give Britain or any other nation gives us this precious time, we serve ourselves best—even selfishly, if you will—by submerging all other conflicting and confusing considerations until after this elemental purpose of our aid has been served.

Therefore, as we now come to a consideration of our economic security, I wish to re-emphasize with all the force at my command the fact that the requirements for our *physical* security come *first*, without quibble or question; and that any economic consideration must immediately be subordinated the moment it comes into conflict with our primal concern for the protection of our lives and liberties.

Now, against this background, I should like to present the program I mentioned at the outset; a program which attempts to establish a general pattern of the stages and steps I consider essential to the further fortification of our political freedom and the extension of economic freedom to our whole society through the instrumentality of the people who comprise the American free-enterprise system acting in close, cordial, and constructive co-operation with the people who comprise the Government of the United States.

While the steps under the various stages will be set before you in what appears to be the approximate order of their importance, I am sure that it will be apparent to you that each is not a distinct, successive step. Obviously, some require continuity from the time of their initiation; and these I shall try to identify as I go along. Others are overlapping in various degrees. Still others are temporary. Nevertheless, their interrelation will be clearer, I think, if you have the relativity of their importance in mind.

PRIVATE ENTERPRISE MUST TAKE THE INITIATIVE

Connected with the relativity of these stages and steps, in terms of importance, I should like also to emphasize the importance of timing the actions I shall propose by stages. This I consider to be extremely important, because some of these steps, taken too soon or too late, could very easily have an effect contrary to that sought.

Also, it will be evident that some of the elements of this pattern are logically within the province of government; that others are logically within the province of private enterprise; and that still others are of an uncertain category. The point to be re-emphasized in this connection—and it is a point requiring very special emphasis—is that the components of the private-enterprise system should take the initiative in defining the obligations the whole system can and will positively assume, while collaterally and co-ordinately it defines those obligations which it will actively support government in assuming. In this suggestion, I present no thought of arm's-length co-operation, overshadowed by suspicion between government and business. Instead, I seek arm-in-arm concord and co-ordinated effort in the common good; the kind of concord and effort which can, in my judgment, eliminate the causes of conflict, competition, and confusion between government and business.

At this point, also, I should like to recall my remarks made earlier in this discussion suggesting that we might very readily delude ourselves if we fall into the error of laying our plans on the premise that when the next peace papers are signed the national emergency will cease and we shall return to that nebulous state known as "normal living". I recall these remarks in order to make the point here that, in my belief, world conditions in 1943—and 1944—and 1945, coupled with an acceleration in the obsolescence of defense materials, will require this nation to devote much more of its energy and its substance to defense production than is generally believed probable by the majority of people today. Therefore, while I believe that the peak of defense production and employment will be passed during the next two to four years, I also am of the opinion that the prospective reduction in employment, after this point has been passed, may be measured in terms of from three to six million people (rather than ten to twenty million as some quite sincerely believe)—unless the private-enterprise system, in co-operation with government, starts right now to plan the way to keep all employables employed; and in my estimate I include those who may lose their jobs both in direct defense production and in the production of normal needs for which the demand can diminish.

A PROGRAM——RECOVERY STAGE

For our *economic* security, then, upon which our cherished democratic way of life and our dynamic free-enterprise system may depend for survival during the coming dangerous decades, I submit the following program.

The first period in this program I identify as the "recovery stage". This is the stage in which we now are, and in which I believe we shall remain until the Federal Reserve Board's Index of Industrial Production (unadjusted) averages 140 during a two-months period. This figure roughly represents the absorption of 90 per cent of all employables and approximately the same percentage of all effective production capacity now available.

In this recovery stage we need:

1. A sincere, determined, and unswerving devotion to democracy, coupled with a clear understanding of and infinite patience with its deliberative processes; and need I say that this is a primary and everlasting essential?

2. Universal respect for the rules which the people through their freely chosen representatives establish for the protection of their rights; which of course is only another way of saying universal respect for the sanctity and the spirit of the laws of our land; quite obviously an eternal essential.

3. A wholly free and enterprising system of free-enterprise; another continuing necessity.

4. Full-time employment of all employables; this, too, is always essential to total economic security.

5. The free flow of all goods, purchasing power, and enterprise capital for production.

6. The encouragement and development of new inventions, accompanied by aggressive promotion of pioneer products. (Parenthetically, I submit this essential in economic security as a very special responsibility of electrical engineers; and this, too, is a continuing necessity.)

7. Rural electrification and the industrialization of agriculture, to the end that a strong agricultural economy and contented people on our nation's farms may be the constant companions of and constructive contributors to a strong industrial economy comprised of contented people.

8. Development of hemispheric self-sufficiency, through the development of South America as a source of raw materials; a development which should be subsidzied if necessary. Clearly this, too, is a continuing necessity, as I shall later try to emphasize in connection with another reference to our relations with South America.

These, then, are the requirements of the recovery stage.

A PROGRAM——STABILIZATION STAGE

Now we come to what I label the "stabilization stage"; the period immediately after the Federal Reserve Board's Index of Industrial Production (unadjusted) has averaged 140 for two months. The necessities in this stage are as follows:

1. Credit and price control against inflation, against long term commitments on durable consumer-goods purchases, and against nonessential personal loans.

2. Maintenance of a full supply of normal needs of a nondurable character to all stratas of society; still another continuing necessity.

3. An acceleration of the modernization of industry, including within that identity all power, transportation, communication, and other utilities; again a continuing necessity, to the end that we always may be in a position to provide more goods and services for more people at less cost.

4. Gradual reduction in governmental activities, expenditures, and loans connected with all nondefense purposes in the conventional field of private enterprise.

5. Taxation to balance the nondefense budget—a step which, with the one just passed, you will notice I place in the second stage of this program because we want no restraints upon employment and increased purchasing power in the first stage.

6. Industrial development of the temperate zone of South America; another continuing necessity, which should be aided by subsidy in the degree necessary.

HEMISPHERIC SELF-SUFFICIENCY

Here may I interrupt this step-by-step presentation long enough to say that special emphasis is given to the development of hemispheric self-sufficiency and to the industrial development of the temperate zone of South America for these reasons:

It is my belief that, no matter what may be the outcome of the present phase of the foreign revolutionary movement, political and economic slavery—if not actual slavery—will prevail. Fleeing from this slavery—a slavery which will be most intolerable to the best minds in the war-torn countries—the oppressed will find ways, no matter how perilous these ways may be, to migrate to this hemisphere hoping that here in the still new world they will find a haven where a new beginning in an atmosphere of freedom may be made. Similarly situated, our forefathers of every race and creed did this in the seventeenth and eighteenth centuries; and just as, in these centuries, our forebears from across the seas developed our continent, these twentieth century immigrants can develop the South American continent to the advantage of themselves, of the countries of their adoption, and of the whole Western Hemisphere. Therefore, humanitarian considerations connected with these prospective immigrants suggest that we help our South American neighbors to prepare themselves industrially to support these people while the latter in turn are preparing themselves to make their contributions to the industrial growth, to the crafts and culture, and to the security of the continent to the south of us.

In addition to this humanitarian consideration, self-interest suggests this help because a strong, self-sustaining, self-defending South American continent obviously will add immeasurably to hemispheric security and hence to our own security, at less cost to ourselves ultimately.

Further, with their industry growing—and creating, as industry always does, great middle classes which are the mainstays of any nation—our South American neighbors could do much to replace our present and prospective loss of normal trade with the rest of the world; and, again, this would serve the common interests of both continents and strengthen the bonds of mutual understanding and good will.

As I leave this brief consideration of hemispheric collaboration, I should like to make very clear that what I have in mind is, in fact, collaboration with the *interests* of our neighbors in the Americas as the primary concern—not commercial exploitation of the character which, too often, has created hemispheric discord.

A PROGRAM——BACKLOG-BUILDING STAGE

Now, returning to our step-by-step consideration, we come to what may be called the "backlog-building stage"—the stage during which we undertake to dam up a part of the demand for goods in order that we may have a reservoir of nonessential unfilled wants in reserve for the days ahead, when employment connected with defense could diminish in a degree sufficient to be dangerous to our economy and to our way of life. This is the stage which will be reached when the Federal Reserve Board's Index of Industrial Production (unadjusted) has averaged 145 for two months. In this stage we shall require the following steps:

1. Further credit and term restraints upon durable consumer goods purchases and nonessential personal loans.

2. The encouragement and expansion of individual, industrial, and governmental reserves in cash or its equivalent. This we may accomplish through:

   a. Personal savings, induced by the active promotion and sale of government savings stamps and bonds of small denominations—stamps and bonds which serve the additional purpose of providing the people at large with a means of sharing in the financial support of our national defense effort;

b. Increases in the amounts of payment, the extension of coverage, and the extension of the time period under our unemployment insurance laws;

c. Increases in the amounts of payment and the extension of coverage under our social security laws;

d. Medical and hospitalization insurance on a national scale for the people of our country whose insufficient incomes do not permit them to purchase this protection from private organizations.

(As I propose larger commitments under our unemployment and social security laws as a socially desirable form of accumulation against adversity, and as I invite the initiation of a national insurance plan to cover medical and hospitalization expenses for the underprivileged, I at the same time propose that all these activities be jointly supported by contributions from every individual prospective beneficiary under these plans, by all employers, and by the government.)

3. Drastic curtailment of all governmental activities, expenditures, and loans connected with all nondefense purposes in the conventional field of private enterprise.

4. Restraints on business expansion loans for nondefense purposes.

5. Taxation for reduction of the national debt.

6. Finally, the diversion of the major portion of sales promotion and advertising expenditures to the speculative promotion of pioneer products.

Here the catalog of requirements of the "backlog-building stage" is concluded.

FINAL STAGE—ULTIMATE CHALLENGE TO FREE ENTERPRISE

And now I come to the final stage—the stage when the private enterprise system will meet its most serious challenge, and therefore the stage which we may very consistently call the "free-enterprise-system-challenge stage". This is the period after the Federal Reserve Board's Index of Industrial Production (unadjusted) has declined—mark this word *declined*—to an average of 150 for two months.

Then, indeed, at a time when our future economic security will be at stake, we must call upon all of our vision and imagination; upon all of our resources; upon all of our ingenuity; and, above all, upon the same deep sense of service that now motivates us, as we move forward in providing the materials for our physical security; to the end that all employables will be kept employed, and that the preponderant majority will find employment on the payrolls of the private-enterprise system.

With these thoughts in mind, then, the following steps represent the needs in this most critical stage—the "challenge-to-free-enterprise stage":

1. Here I submit in all seriousness, as a first step: prayer, and the wholehearted practice of the Golden Rule. And this, I hardly need say, is a continuing, compelling, and comforting requirement; and, happily, that fact is gaining greater force with each passing day as a bedeviled and bewildered world seeks the solace of Divine inspiration from the source of all righteousness and all human rights.

2. Passing from the sublime to the specific: credit and term expansion.

3. More goods and more services for more people at less cost. First of all, more and better housing for more people at a price they can afford to pay. Then more and better furnishings of every kind for these houses, to the end that, within the means of their occupants, these houses may be converted into comfortable, convenient, and happy homes. Then, more consumer goods of every character at lower cost. And, finally, low-cost distribution as a means of filling the people's wants at the least possible cost. Of course, more goods and services for more people at less cost is another continuing necessity.

4. Intensive sales promotion and advertising.

5. Intensification of industrial and utility modernization.

6. Conversion of surplus defense plants, on private property, to the production of goods for the normal needs of the nation.

7. And, finally, permanent government public works.

PRIVATE INITIATIVE—"OR ELSE. . ."

With this outline of the requirements of our most challenging stage, I conclude my presentation of the stages and steps—with the reminder that, as hereinbefore stated, all of the foregoing is an attempt first to present a *realistic* view of the forces underlying the world conflict, and then to provide a *specific basis for discussion*, to the end that, together, we may find the way best to insure our moral, physical, and economic security; the total security I feel we must have if, amidst the destructive forces flooding the world with false philosophies, the democratic process and the American free-enterprise system are to be preserved in their most useful form.

This, then, leaves only a suggestion pertinent to an earlier statement that "the components of the private-enterprise system should take the initiative in defining the obligations the whole system can and will positively assume, while collaterally and co-ordinately it defines those obligations which it will actively support government in assuming". This proposal is that, with this whole presentation as a starting point, public-spirited leaders in finance, in industry, and in commerce consider what kind of a program they can develop, for which they can gain the wholehearted support of those elements representing 70 per cent of the financial, industrial, and commercial power of the private-enterprise system. Then, having established the obligations of business, the manner in which these obligations would be discharged, and the manner in which business would exercise internal self-discipline, they should urge equally enlightened leaders in labor and agriculture to proceed to the same end. Then, finally, after all factors have reconciled their differences and reached an agreement upon the responsibilities they would jointly discharge, government (the servant of all of the people) could have a clearer definition of the public service the free-enterprise system could definitely be relied upon to supply. And, collaterally, government could constructively be presented with a clear definition of the province within which it could operate in the common interest, with the firm and full support of all elements of the private-enterprise system as well as with the support of the general public.

This suggestion is made with a deep realization of the difficulties involved—but it is made also with a comprehension of the fact that the private-enterprise system is faced with two alternatives: Either *private* decisions will be made and enforced by public-spirited and fully supported leaders in finance, industry, commerce, labor, and agriculture, *or public* decisions will be made and enforced

by the government of the whole people for the whole people. Therefore, it must be seen that if no way can be found to make and enforce the first kind of decisions, there can be little justification for resistance to the second kind.

And at this point let us recall to mind the lessons of history. The Magna Charta was the work of a few wise and courageous men whose minds and hearts were brought into concord by their common zeal for service in the common good. This, too was true of our own Declaration of Independence and of our cherished Constitution. Yes, these historic guides to greatness were the work of a few men whose words and ideas, falling like a pebble in the center of the pool of world thought, set up ever-widening circles of agreement and support. Now, as I propose that a few wise and courageous men from the ranks of free enterprise—whose minds and hearts are in concord because of their common zeal for service in the common good—get together for the purpose of composing a constitution for the free-enterprise system, I remind you of the process whereby progress is made.

"AWAKE—ARISE—OR BE FOREVER FALLEN"

And as I do so, I also assert that it is the duty of the American free-enterprise system fully to recognize the advent of a new and dangerous era, and, recognizing that fact, to adjust itself in a manner which will permit it to exercise freely its full potentialities for service to the public, while preserving its entirely consistent purpose of producing a profit.

The call to the people who comprise the American free-enterprise system today is the call that all Americans must heed, no matter what their walk of life may be. It is a call best expressed in the words of John Milton, recently quoted by a famous American editor. Milton's cry was: "Awake—arise—or be forever fallen".

As I here repeat that challenging call to you, I am certain that we shall meet it; and I shall conclude this lengthy presentation with a statement of the conviction upon which this feeling of certainty is based.

First, I am completely confident that, notwithstanding the difficulties and dangers before us, the public-spirited citizens who preponderantly comprise the American free-enterprise system will see in this new era not an occasion for disheartenment and despair, but rather, an inspiring and challenging opportunity to regain both the full faith of the common people and the cordial, constructive support of the servant of *all* of the people: the Government of the United States.

Further, it is my firm conviction that my enlightened associates in industry, commerce, and labor will seize this challenging opportunity with a clear, deep, and broad conception of the social obligations of the American free-enterprise system—the system upon which all of us rely in some way or another, no matter what our occupation may be. Holding this conviction, I am equally certain that with this complete comprehension of our opportunities, of our obligations, and of the character of the challenge confronting us, we shall all play our full part earnestly, enthusiastically, and effectively.

Finally, my most positive and most comforting conviction is that, as we thus play our full part in sustaining the dynamic character of our democracy, we shall have the soul-stirring satisfaction of knowing that we have done our full duty, the duty of providing our noble nation with the solid foundation of moral, physical, and economic security—the solid foundation of total security upon which we, as a free, friendly, and united people shall continue courageously to construct an ever greater and grander America.

Electric Ship Lighting 60 Years Old

THE year 1940 marked the 60th anniversary of the lighting of steamships by electricity, and even though the first commercial installation of a marine lighting plant in 1880 saw oil lamps standing by in case of failure of the new-fangled power plant, that original equipment, designed, built, and installed by Thomas A. Edison, saw active service for over 15 years with only minor changes and repairs. (See picture, page 127.)

This first and historic power plant for steamships was installed on the steamship Columbia, built for the Oregon Railway and Navigation Company by John Roach at Chester, Pa., in 1879. Early in 1880, the vessel docked at New York to be fitted out for its trip around Cape Horn. The electric light plant was installed at that time. It consisted of three 100-volt constant-potential dynamos constructed at Edison's laboratory in Menlo Park, N. J. Each dynamo was capable of supplying 60 16-candlepower lamps. A fourth dynamo, used to excite the others, was run at half speed.

Edison thoroughness was in evidence in controlling switches, insulation consisting of rubber tubing over the paraffin-cotton-covered wire where it passed over metal, and a generous supply of safety devices such as cutouts and fuses. Original sockets were of wood, suspended by the supply wires to avoid shocks which might break the fragile glass chambers. Lights in the staterooms were controlled by the steward from outside. All fixtures were so arranged that oil lamps could be substituted quickly should the electric power system fail.

The ship sailed from New York in May 1880, carrying 13 locomotives, 200 cars, and other equipment. In a letter to Mr. Edison, dated February 24, 1882, John C. Henderson, the advising engineer of the Oregon Railway and Navigation Company said, "On the night of the 2nd of May, 1880, we started up the dynamos and from the time when the steam was first turned on until the present, they have worked to our entire satisfaction under all circumstances."

The plant served a long period of usefulness. It was not until July 1895, after more than 15 years of continuous operation without repairs, except for minor details, that it was taken out when the ship was overhauled and a plant of more modern construction installed in its place.

George Ashley Campbell—Edison Medalist

"IN RECOGNITION of his distinction as scientist and inventor, and for his outstanding original contributions to the theory and application of electric circuits and apparatus" the Edison Medal for 1940 was presented to Doctor George Ashley Campbell, retired research engineer of the Bell Telephone Laboratories, at a special session of the AIEE 1941 winter convention, Philadelphia, Pa., January 29. Highest award of the Institute, the Edison Medal is presented annually to a resident in the United States of America or its dependancies, or of the Dominion of Canada, for "meritorious achievement in electrical science or electrical engineering or the electrical arts."

At the presentation ceremonies, L. W. W. Morrow (A'13, F'25) chairman of the Edison Medal committee, briefly outlined the history of the award; and AIEE Past President Frank B. Jewett (A'03, F'12) spoke on the contributions and personal qualifications of the medalist who has been his "associate and friend for more than 35 years." Following Doctor Jewett's remarks, AIEE President R. W. Sorensen (A'07, F'19) who presided over the ceremonies, presented the medal and certificate to Doctor Campbell.

Essentially full text of Doctor Jewett's address and Doctor Campbell's response follow on this and succeeding pages.

Qualifications of the Medalist

FRANK B. JEWETT, Past President AIEE

THE QUESTION as to how old the application of science to industry is I do not propose to ask, for attempting to answer it might prove tantamount to trying to pick a date so early that no one else could think of an earlier one. But while the date of the first application of what we might reasonably denote as scientific knowledge to practical affairs is undoubtedly lost in antiquity, the date at which industry first realized the practical importance of scientific knowledge sufficiently clearly to go out in active search of such knowledge, is surprisingly close at hand. In fact, I think I should be committing no great exaggeration if I said that it falls within one man's active life, and that man our 1940 Edison Medalist.

I do not say that American industry was the first industry to organize itself for the discovery and application of such knowledge as would be particularly useful in its chosen field; certainly I do not wish to imply that the laboratory which George Campbell joined back in 1897 was the first industrial laboratory of applied science. But it was certainly one of the very earliest, and I have no fear of being contradicted when I say that the venture upon which he embarked was to carry him into what was then an utterly uncharted sea. Indeed, to most people at the time, it appeared not only uncharted, but decidedly threatening. To many it was absurd and some even were frankly hostile—just why I never knew.

I seriously question whether today, with a long record of success behind, those who themselves were not among the pioneer contingent can really appreciate the courage and adventurous spirit which the undertaking demanded of the early industrial pioneers who risked their hard-earned cash upon efforts spent in trying to add to man's store of physical knowledge. It was one thing to attempt to utilize knowledge already gained, but quite another to spend money upon the winning of new knowledge in the hope that it would prove useful.

In this connection I am continually struck by the nonchalance with which a younger generation of research men utilize the methods, tools, and techniques at their disposal for *their* pioneering as though they had always existed. The fact that they were nonexistent or were serious problems for their own immediate predecessors seems to come as a shock.

And I know firsthand that it seemed to many a particularly wild, fantastic gamble to add a mathematician to an industrial staff and contract to pay him a wage without any commitment on his part that he could make his special language bring new meaning to the work in hand Of course, it is true that the submarine cable problem had yielded years before to Kelvin's analysis, but it was equally well known that the solution Kelvin obtained for that earlier communication problem was of no value to the telephone engineer when it came to making a successful long-distance speech circuit.

Perhaps we get our clearest conception of the fast pace at which science and industry have been moving when we stop to recall what progress has been made within the span of Campbell's active career. Within the domain of industry alone, the few small inquisitive groups of his early years have expanded and grown to thousands of laboratories, some of which employ thousands of workers. We may say truly of our medalist, therefore, that he was a pioneer among pioneers. Not only did he show the courage and fortitude of the explorer when, as a mathematician, he entered a new and untried department of industrial effort, but throughout his long and active life he has won outstanding successes by tackling unpromising situations and literally living with them until he had mastered every difficulty and straightened every devious turning.

In this connection I am reminded that Campbell's undergraduate college training was that of civil engineering. He must have had a good master—indeed, I know he had a good master because it was none other than Professor George F. Swain, then of Massachusetts Institute of Technology and later of Harvard University. In his later work Campbell has certainly exemplified the best qualities of the surveyor by moving, as I have said, into one uncharted region after another, to leave each only after he had completely mapped its topography and

left it a land whose natural resources he had exposed for all those who chose to follow the trails he blazed and to employ the riches he marked with his "section corners" and "witness trees."

I wonder how many realize what a difficult task this is, especially in the atmosphere which industry provides. In the type of mathematical exploration which Campbell has carried on, he has been necessarily and essentially a lone worker. There was no tramp of many feet just behind him. His work was always far out in front of the main column. Industry's greatest efforts usually occur in departments long since fully explored. In other words, Campbell as a pioneer found himself in surroundings where it was peculiarly difficult to "keep his eyes in the boat." His slow and uncertain progress at times, it seems to me, must necessarily have struck discouragement to his heart as he beheld the more commercialized ventures around him forging ahead into production or use and, what may be even more important, into a conspicuous place in the minds of management and the public.

So here again Campbell has proved himself a man of unusual courage. Repeatedly throughout his career he has staked his all upon an issue he alone envisaged and which at best could not reach its zenith of recognized importance till years afterward. It is one thing for the research man who occupies a university position to do this with equanimity, but it is quite another matter for one surrounded as Campbell has been by the impetuous atmosphere of industry, to do it.

I presume there have been few medal presentations in which most of the time was not spent in reciting the medalist's contributions. In the present instance, such a procedure seems scarcely necessary. Campbell's outstanding discoveries, particularly the loading coil and the electric wave filter, are well known—in fact, have become almost as familiar in modern technical parlance as the electric motor or the internal combustion engine. But strong as the temptation is to describe at greater length the very lovable and laudable personal qualities of the man, I realize that at least passing reference should be made to his outstanding technical contributions.

The first of these was the loading coil for extending the range and improving the quality of long telephone lines as well as for conserving copper. In this field he was not alone. In fact, after final adjudication under the technical rules of the patent law, the basic patent was awarded to Pupin, on the ground of priority of conception. But Campbell, then a young man, did his theoretical and experimental work without any knowledge of the study his rival had in hand. Further, I have no hesitation in saying that Campbell's analysis of the problem was actually more comprehensive then Pupin's. It led him to formulas for the design and spacing of loading coils which were superior, so that from the very beginning of practical application, they alone were employed for building loaded lines in the United States and abroad. By this one piece of work performed within a relatively short time after his employment in the Bell company in Boston, Campbell demonstrated his unique ability at mathematical physics, as well as his knack for stating conclusions in a form that the development engineer could use in practical applications.

To review the history of loading and the immense benefits which it conferred, not alone on the infant art of telephony as it existed at the time, but even more upon the highly developed art as it exists today, would carry us too far afield. However, there is one not generally appreciated aspect of loading which merits mention here.

With the introduction of loading, inductive effects resulting in the phenomenon of crosstalk between neighboring telephone circuits were more evident, and coping with them became more of a problem for the telephone engineer. So, too, did the effects of insulation.

The Edison Medal, highest award of the AIEE

The medal was founded by associates and friends of Thomas A. Edison, who desired to commemorate the achievements of a quarter of a century in the art of electric lighting with which Edison had been so prominently identified, and to serve as "an honorable incentive to scientists, engineers, and artisans, to maintain by their works the high standard of accomplishment" that had been set by Edison. AIEE was invited to undertake the responsibility of making the award, and the medal was established on February 11, 1904. Awards of the medal have been made to the following:

1909 Elihu Thomson	1925 Harris J. Ryan
1910 Frank J. Sprague	1927 William D. Coolidge
1911 George Westinghouse	1928 Frank B. Jewett
1912 William Stanley	1929 Charles F. Scott
1913 Charles F. Brush	1930 Frank Conrad
1914 Alexander Graham Bell	1931 E. W. Rice, Jr.
1916 Nikola Tesla	1932 Bancroft Gherardi
1917 John J. Carty	1933 Arthur E. Kennelly
1918 Benjamin G. Lamme	1934 Willis R. Whitney
1919 W. L. R. Emmet	1935 Lewis B. Stillwell
1920 Michael I. Pupin	1936 Alex Dow
1921 Cummings C. Chesney	1937 Gano Dunn
1922 Robert A. Millikan	1938 Dugald C. Jackson
1923 John W. Lieb	1939 Philip Torchio
1924 John W. Howell	1940 George A. Campbell

While it had been shown by earlier workers that crosstalk was a complex effect of both electromagnetic and electrostatic induction in which the latter was frequently the more important, I believe Campbell first reduced the various factors to such a computational basis as was both accurate and readily manageable. He pointed out the importance of Maxwell's capacity coefficients and coined the term "direct capacity," now modernized to "direct capacitance." He showed in these early memoranda

that crosstalk between two circuits depends to a considerable extent, and particularly in the case of loaded lines, on a function of the various direct capacities between the wires of the two circuits. He termed this function the "direct capacity unbalance."

Campbell's studies led not only to mathematical formulas but to the development of measuring apparatus which was destined to play a great part in future telephone developments. For it was in this period that he produced his well-known shielded balance for the accurate measurement of electrical constants at telephonic frequencies. It is interesting to remark in this connection that in this early work we have the genesis of the whole shielding technique as applied today in innumerable ways in the high-frequency art. Also, out of it grew a simple method for measuring direct capacitances, as well as capacitance-unbalance test sets which have played a fundamental role in the manufacture, installation, and maintenance of telephone toll cables.

The ancillary problems which arose out of loading as a method of extending economically the range of telephony and whose solutions originated largely in Campbell's powerful intellect are striking examples of a phenomenon many times repeated in the history of telephonic development. The introduction of a new and useful thing demands a more adequate and refined structure in which to function. The getting of this new structure—usually at added first cost—brings in its train elements of greater reliability, better service, and more economical maintenance than the old one possessed. Not infrequently these incidental things, which in themselves might never have presented problems thought worthy of attack, turn out to have equal or greater value than the thing which initiated their solution.

Closely associated with Campbell's analysis of the loaded-line problem, and indeed springing from it, is that of the electric wave filter. This is undoubtedly one of his most important and also best-known contributions. Today in nearly every phase of telephone transmission, as well as in many other departments of electrical engineering, filters play an important part; their future role promises to be an expanding one and one which again is not, by any means, confined to telephony.

Turning to the telephone repeater art which plays such an important part in the modern telephone plant, we again find evidence of Campbell's masterly hand. The type of line balance involved in repeater operation early attracted his attention. The early repeater development involved two problems: first, to secure as nearly as possible a perfect amplifying element; and second, to adapt this element to the telephone line.

George Ashley Campbell

1940 Edison Medalist

What is involved in this second problem can only be appreciated by the telephone engineer who has had experience in the transmission art. Early in the development of telephony it challenged attention. Before Campbell attacked the problem various experimenters and inventors had proposed circuits to accomplish two-way telephony, and out of this prior work had come rather empirically two fundamental repeater circuits, namely, one in which a single repeating element amplifies messages reaching it from both directions, and one which includes two amplifier elements, one assigned to each direction of transmission. These repeater circuits came to be known as the 21-type and the 22-type, respectively. In the 21-type repeater, two sections of line as nearly identical as possible are balanced against each other as opposite arms of a bridge. In the 22-type repeater, each incoming section of line is balanced against an artificial line or network, thus permitting, as Campbell's analysis showed, a greater inherent flexibility as well as a greater stability. The inherent stability limits of these circuits, however, were not clearly formulated until Campbell made a study of the circuits.

In the same memorandum he suggested the use of the "four-wire circuit" as a logical extension of the one-way paths in the 22-type repeater, each extended path containing as many one-way amplifiers and line sections as desired. This was in 1912, and the four-wire circuit, although now so widely used both at voice frequencies and in the carrier art, appeared at that time to have little practical application. It was proposed as a structure possessing very great stability, relative to the other types of repeatered lines, and as such was recognized as of great technical interest, if not of immediate commercial value. It was an example of a technical advance destined to be employed only after a complex art had caught up with it.

Turning to the subscriber's set, we find again the indelible impress of Campbell's mind. He was the originator of the single-transformer anti-sidetone circuit which is now achieving almost universal acceptance. But more than this, he did a masterful piece of work in revealing all of the possible circuit arrangements having doubly conjugate branches, and in setting down the impedance relations of the line, network, transmitter, and receiver for these various branches. This systematic analysis of the problem greatly facilitated a comprehensive survey, giving assurance that all types of circuits were being considered and that those best fitting the best transmitters and receivers available at any time were being selected.

In closing I want to return again to George Campbell, the man, and here I feel that I cannot do better than quote from one of his former colleagues, Doctor E. H.

Colpitts. In writing of Campbell some years ago, he said:

"In common with many other truly great minds, it has been his choice to avoid publicity and public appearance, so that outside the circle of his immediate associates and a few of the more mathematically gifted students of his chosen branch of electrical science, his fame is far from commensurate with his achievements.

"In Campbell's case, lack of participation in public activities must not be interpreted as indifference or lack of interest in the common welfare. He has shown himself in the highest sense to be an idealist, and having once aligned himself with a cause, he has served it devotedly without regard to the toll of effort it might exact from him personally. He has been more than a pioneer and inventor. His mode of life and work has been as much an inspiration as his technical contributions are foundation stones of the telephone art. His self-sacrifice and devotion will long linger in our memories, and his serenity sets a high goal toward which we, in our individual efforts, will aspire but seldom reach. Viewing his long and successful career, we realize anew the profundity of Emerson's declaration, 'the great man is he who, in the midst of the crowd, keeps with perfect sweetness the independence of solitude.'"

To this tribute I should like to add a personal one for the man who has been my associate and friend for more than 35 years. In doing so I will use one word which Colpitts has quoted from Emerson in an even broader sense.

Nothing I could say would add to the distinction of Campbell's scientific accomplishments—they speak for themselves. I can appreciate the results and in a way the scholarly grandeur of the attack. Beyond that I belong among those who follow where he has led.

In one sector of appraisal I yield precedence to no man, however. Here, after more than half a lifetime of association I can sum up that appraisal in a single word. He is in every sense a "sweet" man. I feel certain that in Doctor Campbell we have one who, from every point of view, is a fit recipient of the Edison Medal.

The Pursuit of Curiosity

GEORGE A. CAMPBELL, 1940 Edison Medalist

I DEEPLY appreciate the honor of receiving the Edison Medal for 1940. It is quite impossible for me to understand why I should have been singled out among all the persons who must have been considered by the committee. The only clue which I have discovered came to me in this way.

Last week when taking a walk I happened to pass the Montclair pumping station, and turned in to watch the superintendent who was busy repairing water meters. He explained to me, in detail, the nature of the damages which bring water meters to his bench. I left the pumping station quite elated that I had added to my meager knowledge of this most common instrument with its wobbly disk. This little experience prompted the thought that curiosity was as good an explanation of the Edison Medal award as I could find.

My father was an excellent teacher of physics and mathematics, and he did much to stimulate my curiosity about these subjects. It was curiosity which stimulated my study of them in school and college, and which lured me to Europe and on from university to university. When this irresponsible vagabond life would have ended I have no idea, had not my money come to an end, and the remittance arrived from my father for the passage home.

At the age of 27 I awoke to the realization that I had been motivated merely by curiosity in choice of universities and studies, and that I had produced nothing of my own, and had not given a thought to preparation for earning a living.

Curiosity had entertained me for 20 years, but I found no one who was looking for an employee of that description. At length I applied to Doctor Hammond V. Hayes of the American Bell Telephone Company in Boston, Mass., and was given there the first and only permanent job I have had, barring change of place and organization in the Bell System.

In the Bell System I have found the greatest opportunity for the pursuit of curiosity. It was a fascinating field 40 years ago, and during that interval its expansion has been phenomenal, both quantitatively and qualitatively. What was even more important in my own case was that I became a part of a research and development organization with clear-cut goals, high standards of performance, recognition of the importance of the division of labor, and the advantage of teamwork. Doctor Hayes soon assigned to me a theoretical study of transmission on telephone lines and the distribution of currents in telephone networks. For nearly 40 years I worked in this field with the greatest satisfaction. I specialized more and more, and there my training in European universities doubtless asserted itself. In both France and Germany I had been much impressed by the air of thoroughness which pervaded research, and by the fact that few, if any, investigators published papers till they had become well saturated with their subjects. I believe it has been very helpful to me that my curiosity was thus taught to hold itself in check, and not to leave a subject before a reasonably complete survey had been made.

In the Bell organization, I was assigned assistants who could do many things with greater dispatch and efficiency and perfection than I could. To some of these assistants I later reported myself, and others have carried on the work into difficulties which I myself could never have surmounted.

You will see that it is perfectly natural that I am an admirer of that kind of teamwork which represents a division of labor in the intellectual field. At one and the same time it gives a greater opportunity to those whose talents lie within rather narrow fields, and it results in an integrated product greater than the sum of the individual efforts. For reasons I have just explained, I feel that I am a beneficiary of the group method attacking scientific problems. Without the collaboration of innumerable associates, in the Bell System, the contributions you have designated to be mine, I probably should not have succeeded in making. It is a distinct pleasure to me to recall these many associations and to testify that those who have been my colleagues over the years are in large part responsible for the honor of receiving the 1940 Edison Medal.

New Subway Link Completed in New York

Opening of the new Sixth Avenue subway in New York City, December 15, 1940, marked the completion of the most difficult and most expensive subway for its length ever constructed. Although only $2\,^1/_4$ miles long, its total cost was approximately $60,000,000. It embodies the latest equipment and practices in the subway art.

ALTHOUGH only $2^1/_4$ miles in length, and comprising only $7^1/_2$ miles of track, the Sixth Avenue subway in New York City, which began operation December 15, 1940, is significant for at least two reasons: It involved practically every known type of subway construction at various points along its length; and it embodies the latest equipment and practices in the art. Construction obstacles of unprecedented type and number for so short a line were encountered in the construction of this latest addition to the subway system in New York, with the result that its cost per mile was the highest of any line that has ever been built. The cost of construction, exclusive of equipment, tracks, and station finish, amounted to some $46,800,000; the total cost was approximately $60,000,000.

The line forms an essential link in the so-called IND* Division of the New York City transit system[1,2] for which a route and general plan was adopted by the Board of Transportation of the City and approved by the City's Board of Estimate in 1925. The line was required: (1) to furnish necessary north and south trackage between 53d Street and Christopher Street, at which points it connects with the previously existing system; and (2) to give access from that entire system to the theater, shopping, and business districts contiguous to Sixth Avenue. Construction originally was planned to begin in 1928. However, because tunnel No. 1 of the New York City Water Supply System is built directly under Sixth Avenue for a major part of the distance covered by the new subway, construction was deferred until tunnel No. 2 was completed and in service (1936), on account of the possible hazard to tunnel No. 1 during the construction period due to the use of dynamite in rock excavation.

The completion of the Sixth Avenue line brings the total route miles of the Independent Division to 55.6, and the total track miles to 230.6. Comparable figures for the other two subway and elevated divisions in the City of New York are: IRT Division, 99.3 route miles and 302.9 track miles; BMT Division, 96.0 route miles and 282.1 track miles. The totals for all subway and elevated lines in New York City, therefore, are 250.9 route miles, and 815.6 track miles (including yards). These three divisions, which now are combined under the unification program recently adopted by the City, comprise an electric railway system of no small magnitude. In density of traffic, particularly during morning and even-

Material for this article was obtained partly from the published material indicated in the list of references at the end, and was supplied partly by various members of the Board of Transportation of the City of New York and by the General Electric Company. The generous assistance of all who supplied this material is gratefully acknowledged.

* In June 1940 the City of New York purchased the properties of the old BMT and IRT Subway Systems and renamed them the BMT and IRT Divisions of the New York City transit system, and renamed the former Independent Subway System the IND Division of the New York City transit system.

1. For numbered references, see list at end of article.

ing rush hours, this system ranks second to none.

Among the more significant new equipment installed on the Sixth Avenue subway are the rectifiers which convert the a-c supply to direct current for propulsion of the trains. These are 12-phase units, comprising 12 single-anode tanks of the ignitron type. They are installed in underground compartments adjacent to the subway structure, and are unattended, being operated through supervisory control from a central point from which all substations on the system are controlled. Other equipment is essentially the same as adopted earlier for the Independent subway, the first 12-mile section of which was placed in operation September 10, 1932.

The Sixth Avenue line includes five stations, two of which have side platforms, and three island platforms (between express and local tracks). All station platforms are 660 feet long, except at 34th Street where the east platform is 800 feet long, and the west platform 700 feet. All stations are adequate for the operation of 11-car trains, although present plans call for maximum train length of 10 cars. Complexity of construction of the stations parallels that of the remainder of the line. Direct access is provided from department stores in Herald Square, as well as with the intersecting BMT line and the Hudson and Manhattan Railroad, which terminates just south of 34th Street. At the 47th–50th Street station, direct access is provided to three large office buildings of the Rockefeller Center group. In addition, a pedestrian passageway 25 feet wide was constructed under the center of Sixth Avenue over the subway roof connecting the 34th Street and the 42d Street stations, with entrances to this passageway along Sixth Avenue at 34th, 35th, 38th, and 40th Streets.

CONSTRUCTION

The Sixth Avenue subway involved almost every type of subway and tunnel construction used in New York City—compressed-air shield tunneling, rock tunneling at normal air pressure, and the usual cut-and-cover construction—and many obstacles were encountered in building it.[3] Probably no other subway in New York ever was constructed through a more congested area or required to be built for a distance of $1^1/_8$ miles adjacent to an operating subsurface railroad and throughout its length of $2^1/_4$ miles cross over and under as many operating subsurface railroads as the Sixth Avenue subway. Not only was it necessary to construct this line through one of the most congested traffic areas of the city and under a street unusually congested with sewers, water and gas pipes, telephone, telegraph, and power lines, steam mains, and other subsurface facilities, but the presence of the Sixth Avenue elevated railroad required that 670 elevated columns be picked up, temporarily supported during construction, and finally transferred and supported on the roof of the new subway, practically all of which was performed before the elevated railroad structure was removed. The Sixth Avenue elevated railway structure was privately owned, and authority by the State Legislature to have it removed was not obtained by the City until after construction of the subway has been started. It cost the City about $5,000,000 extra to build the subway under the elevated structure. The removal of the "L" transformed Sixth Avenue from a dismal, noisy, and unsightly thoroughfare into a boulevard, comparable on the west side of Fifth Avenue to what Madison Avenue is on the east.

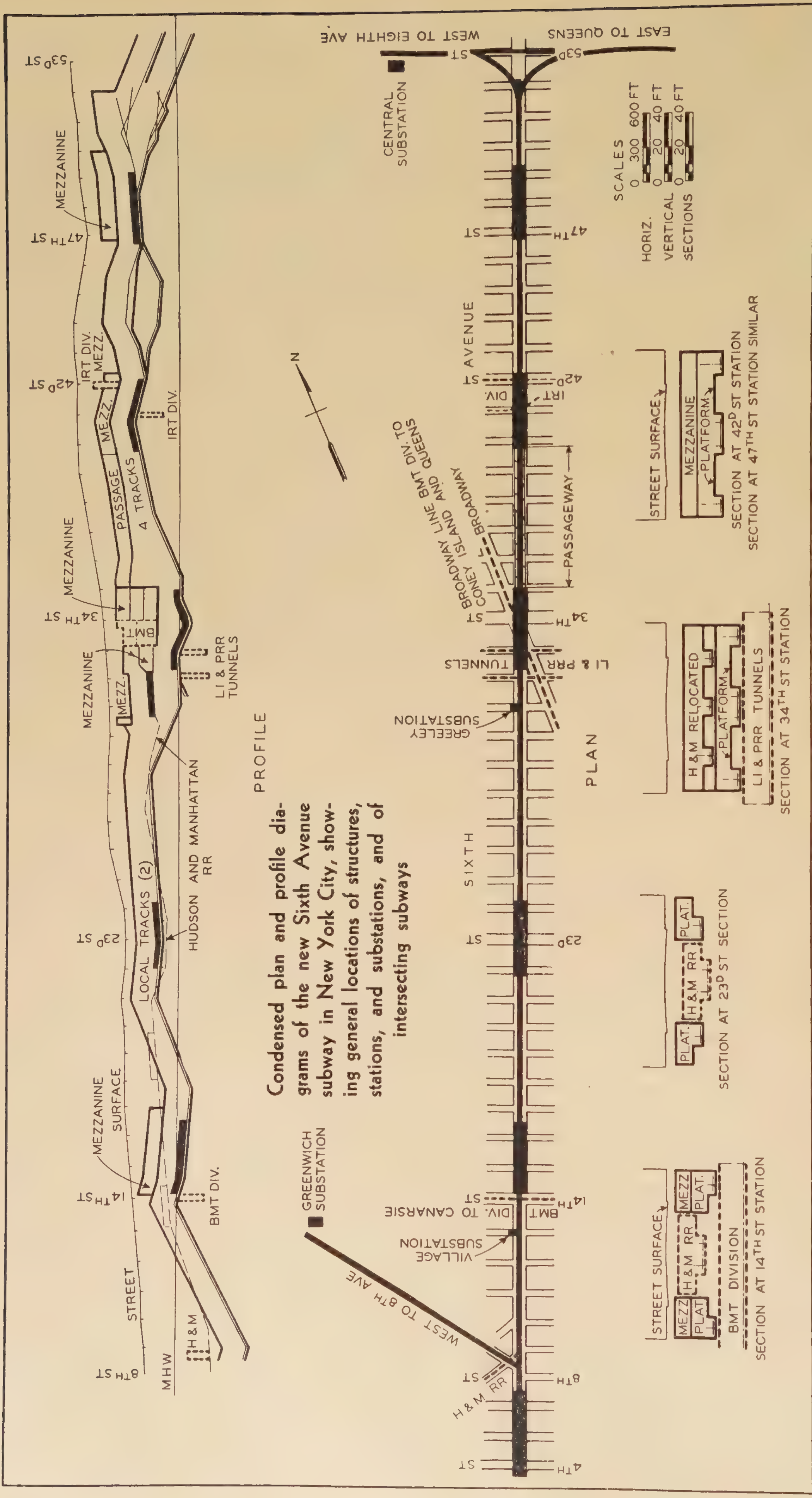
The majority of the buildings along Sixth Avenue were required to be underpinned or otherwise protected, and six existing subway and railroad tunnels crossing Sixth Avenue were required to be either spanned over or tunneled under. In addition, it was necessary to cross under, support, reconstruct, and maintain the Hudson and Manhattan Railroad, a two-track structure extending under the center of Sixth Avenue from 9th Street to 33d Street, while constructing the new subway adjacent to and partly under this structure. All this work had to be performed without interruption of service on the transit lines or undue inconvenience to the vehicular or pedestrian traffic, at the same time maintaining satisfactory facilities to the property owners and patrons of the stores and shops along Sixth Avenue.

The presence of the Catskill Aqueduct under Sixth Avenue between 53d and 33d Streets required unusual care in the use of explosives in the removal of the rock and limited the amount of excavation made in advance of the completed subway structure in order not to remove too much of the rock cover over the aqueduct before replacing it with the steel and concrete of the new subway structure.

The foregoing indicates some of the obstacles encountered in constructing this line, but nature was not to be outdone as the rock (Manhattan schist) underlying Sixth Avenue was about the worst imaginable. Not only was the surface of the rock found at variable distances below the street surface, but also with a considerable difference in elevation on opposite sides of the street. It was blocky, full of seams, badly faulted in places, and often disintegrated, requiring the construction of concrete retaining walls, and heavy bracing to support the side banks properly and prevent slides.

The plan and profile diagram shown on page 112 indicates the principal construction obstacles encountered. At 9th Street, just north of the existing West 4th Street station where the new subway joins the Eighth Avenue line, the two tracks of the new system were constructed in rock tunnel at normal air pressure, with steel-bent and concrete-arch construction. The two tracks of the Hudson and Manhattan Railroad curve into Sixth Avenue from Christopher Street, under which the tracks of the Sixth Avenue subway cross. Between 10th and 13th Streets, the two tracks, one on each side of the Hudson and Manhattan Railroad, were constructed as a cast-iron-lined tunnel by use of a shield under compressed air, and between 13th and 26th Streets, the construction was by the cut-and-cover method.

At 14th Street, the subway passes over the 14th Street–Eastern line of the BMT Division. Here it was necessary to alter the BMT structure by removing portions of the roof, the invert (or bottom) of the new structure forming the roof of the BMT. Other structural changes required at this point were: extension of the Hudson and Manhattan platforms about 100 feet south and re-



Condensed plan and profile diagrams of the new Sixth Avenue subway in New York City, showing general locations of structures, stations, and substations, and of intersecting subways

moval of a similar portion from the northern end of those platforms, thereby moving the station in a southerly direction about 100 feet; reconstruction of stairways to the BMT structure; erection of new columns for the support of the Hudson and Manhattan and Sixth Avenue structures through the platforms of the BMT station. At 23d Street, it was also necessary to alter the existing Hudson and Manhattan station.

Between 26th and 31st Streets, the surface of the rock is higher, so that the two tracks of the new subway were constructed in a rock tunnel with steel-bent and concrete-arch construction. At 31st Street, the two tracks emerge from the rock tunnels and enter a cut-and-cover section, changing to a four-track structure between this point and 53d Street. Between 31st and 33d Streets, the Hudson and Manhattan structure was removed in order to construct the new subway. Later, the Hudson and Manhattan terminal station at 33d Street was reconstructed. In the meantime, it was necessary to establish a temporary terminal at the existing Hudson and Manhattan station at 28th Street. This required the construction of passageways on both sides of Sixth Avenue and provision for additional entrances at 29th Street. It was also necessary to alter the existing Hudson and Manhattan structure between 29th and 31st Streets, and install signals and equipment to

provide facilities for turning of trains of that road.

At 32d and 33d Streets the subway was constructed over the tunnels of the Long Island and Pennsylvania railroads; in order to provide sufficient space for the construction of the new subway, it was necessary to remove the existing roofs of these tunnels, the invert of the subway structure forming the roofs of the tunnels.

At 34th Street, Sixth Avenue intersects Broadway at an angle of some 20 degrees, under which is located the Broadway line of the BMT subway. Probably the most difficult piece of construction was the portion of the new structure directly under this operating subway, which required that the BMT structure be supported without interruption to service. At 41st Street, the Sixth Avenue subway passes over the IRT Queensboro subway, a two-track line built in rock tunnel. In order to construct the new subway, it was necessary to remove the roof over the Queensboro tracks, with the invert of the new structure forming the roof of the Queensboro line. Under 42d Street is the old IRT shuttle which is used for heavy transfer traffic between Grand Central station of the IRT East Side line and the Times Square station of the IRT West Side line. The new subway was constructed under this shuttle line. Here again, in order not to have an excessive grade between 41st and 42d Streets, it was necessary to remove the concrete invert of the shuttle structure, and construct the new subway with its roof forming the invert of the shuttle. This work was performed without interruption to shuttle train service.

Between 43d and 45th Streets, the rock surface was high and all tracks were constructed in rock tunnel. Between 46th and 51st Streets, the four tracks are at the same level and were constructed in open cut under decking. An interesting and intricate layout of tracks extends northward from 51st Street. Four tracks connect with the existing tracks under 53d Street, two curving eastward toward Queens, and two westward toward Eighth Avenue; the other two tracks are dead ended, being provided for a future extension along Sixth Avenue and under Central Park to Harlem and the Bronx.

MAINTENANCE AND RESTORATION OF SUBSURFACE STRUCTURES

In the construction of the Sixth Avenue subway, the maintenance and restoration of subsurface structures presented many difficult problems. A preliminary survey showed that the whole width of the avenue from curb to curb, and in some places the area under the sidewalks, was congested with structures either owned by various utility corporations, or under the jurisdiction of various city departments. For example, at the intersection of 40th Street, were: 15 gas mains ranging in size from 4 to 12 inches; five water mains varying in size from 12 to 48 inches; a 16-inch steam main, occupying a space of more than four feet square; 20 duct banks, comprising about 250 ducts, carrying power, lighting, telephone, and signal cables; and 14 manholes, each ten feet square, and from eight to ten feet deep. To restore all these structures within the limited space between the top of the subway roof and the street surface was the problem.

The procedure usually followed was to place the largest and most important structures into key positions, at the greatest depth of cover over the subway roof, and to restore the other structures around these key positions. Generally, it was possible to do the greater part of the restoration work under the street-surface decking, without interfering in any way with the flow of traffic in Sixth Avenue. At the intersecting streets, however, where structures were most congested, and at some other locations, it was necessary to remove part of the decking. In a few instances, vehicular traffic had to be diverted temporarily into adjacent streets.

Maintenance and restoration of the sewers presented a particular problem. Of all the subsurface structures and utilities the sewers are the least flexible because a continuous downward gradient is required for gravity flow. In many instances, the sewer structures must be built into some portion of the subway structure.

The cost of restoration, by-passing, and other work connected with subsurface structures (not including sewers) varied from approximately 7 per cent of the total cost of the subway structure in the southerly part of the new subway to about 13 per cent in the northerly part. It is interesting to note that the time consumed in the restoration of the subsurface structures was practically equal to that required for the building of the subway structure itself.

ROLLING STOCK

Cars and associated equipment being used in the Sixth Avenue subway are similar to those already in use on the Independent Division.[4] The cars are 60 feet long, 10 feet wide, and 12 feet 2 inches high from rail to roof.

Construction view showing method of supporting columns of elevated railroad, which was not removed until most of the subway structure had been completed

View showing method of supporting the many subsurface structures during construction of the subway

Seats are provided for 60 passengers and are arranged in four groups, in effect dividing the space within the car body into four equal sections, each served by a pair of doors on either side of the car. The total weight is 84,300 pounds; this weight, which is relatively low for a car of this size, was kept down by liberal use of aluminum and by concerted efforts on the part of various equipment manufacturers. The design of these cars was adopted after careful study of both the equipment being used on the older two subway divisions in New York and many proposed new designs, by a joint committee consisting of engineers of the Board of Transportation, and representatives of the other rapid transit systems and of car equipment manufacturers. A model car was first constructed in the office of the Board of Transportation and thereby became a sort of laboratory for car design and specifications.

All the cars are motor cars, no trailers being used on the Independent Division. Each car is driven by two 190-horsepower motors, both mounted on one truck. The second truck of each car is a trailer. All wheels are equipped with clasp-type brakes.

Control equipment is grouped in a permanent cab at each end of each car. Multiple-unit electropneumatic control makes it possible to run a train of from 1 to 11 cars from a single position. Control is of the automatic battery field type, with acceleration set at the rate of 1.75 miles per hour per second; this rate of acceleration is maintained regardless of load. The operating coils of the line switch are actuated by trolley current so that the main motor circuit is opened immediately on loss of power, but the multiple-unit control is operated from a low-voltage storage battery. Braking also is controlled automatically at the rate of 1.75 miles per hour per second.

Lighting of the car interior is obtained from 22 incandescent automatic-cutout lamps in series, each lamp taking 1.6 amperes at 30 volts. These lamps are set in short-circuiting sockets. Four battery emergency lights per car are switched on automatically whenever trolley current is interrupted.

Heating in winter is furnished by electric underseat heaters, and ventilation in summer by five horizontal four-blade electric fans mounted on the ceiling. The car lamps, heaters, ventilating fans, and destination signs have their circuits so arranged that they can be controlled from the motorman's position at the head of the train. Door control is arranged for multiple unit operation, the front half of the train (up to a maximum of six cars) being controlled by the conductor, and the rear half (five cars or less) by the guard. A total of 26 train-line wires through the electric couplers carry battery current for the control of motors, brakes, door engines, lamps, fans, heaters, and destination signs. The use of automatic couplers facilitates the coupling and uncoupling of cars.

PROPULSION POWER SUPPLY

For propelling the trains of the Sixth Avenue subway, d-c power at 625 volts is supplied from four substations (see page 112), which in turn are supplied from the 60-cycle system of the Consolidated Edison Company, as are all substations on the entire Independent Division. Conversion equipment for the new line has been installed in these four substations as follows:

Central substation—2 4,000-kw synchronous converters
Greenwich substation—1 4,000-kw synchronous converter
Village substation—2 3,000-kw mercury-arc rectifiers
Greeley substation—2 3,000-kw mercury-arc rectifiers

Two additional 3,000-kw rectifiers were installed at other points on the system.

The synchronous converters were installed in the two existing stations to operate in conjunction with units already installed. The additional machines brought each of these two substations up to a total of four 4,000-kw converters each. The two rectifier substations are new underground structures built in conjunction with, and adjacent to, the subway structure.

The addition of these units to the conversion equipment of the Independent Division adds a capacity of 30,000 kw, making the total system capacity now 326,000 kw; of this total 65,000 kw is in synchronous conversion equipment, and 261,000 kw in rectifiers. When the Independent Division first was planned, it was expected that synchronous converters would be used throughout.[5] Later, however, the mercury-arc rectifier was developed to the point where it became available for this purpose. Consequently, only five synchronous-converter substations were built for the Independent Division, the remainder being mercury-arc rectifier stations. With six exceptions, all

the latter are underground, being housed in structures adjacent to the subway structure.[6,7]

All substations, both synchronous-converter and rectifier, on the Independent lines are unattended, with control from a central power dispatcher's office in 53d Street. The new substations on the Sixth Avenue line require only additional panels on the control board in that office. Normally, the rectifiers are placed in service and taken out of service by supervisory control.[8] After the starting impulse has been given from the power dispatcher's office, the operating sequence is entirely automatic, protective devices checking the operating conditions before a unit is connected to the bus. If, during the operation, some abnormal condition that could correct itself should occur, an automatic protective device will take the unit out of service; as soon as the condition is corrected the unit automatically will return to service without further attention by the operator. If some abnormal condition necessitating maintenance work should occur, the unit will remain out of service until the trouble has been corrected.

The number of d-c feeders per station depends upon the third-rail arrangement. The four third rails are sectionalized at alternate substations. At substations where the rails are sectionalized, each rail end is fed through a separate feeder circuit breaker, resulting in an arrangement of eight feeders. At the alternate substations where third rails are not sectionalized, the four third rails are tied together through the substation bus, requiring four feeders. All d-c feeders on the system are controlled by 3,000-ampere high-speed circuit breakers, each of which can be opened or closed by supervisory control from the dispatcher's office. Factory-assembled units are used throughout the substations for the control and protective equipment.

Control of the synchronous-converter substations is similar to that of the rectifiers.[5] Machines may be started and stopped from the power dispatcher's office, all operations in the starting sequence being automatic after the initial impulse is given. All operating conditions are checked automatically before a converter is connected to the bus. In these substations, one unit is kept running continuously. As the load increases to a point where one machine cannot carry it satisfactorily, a second machine automatically will start and be connected to the bus. Further increases in load will cause additional machines to be started. The operating sequence is set manually, and changed frequently. Should one machine fail to be connected to the bus, because of some faulty operating condition, the machine will shut down, and the next one in the sequence automatically start.

All d-c feeder cables are 2,000,000 circular mils in size. These cables terminate at cast-copper connectors in insulating housings adjacent to the rails; from these connections, 500,000-circular-mil cables extend to the third rails.

Short-circuit and overload protection is provided for each feeder. After a feeder circuit breaker has opened, the resistance of the feeder is measured automatically. If the measured resistance is 0.3 ohm or more, the breaker will reclose; if less than 0.3 ohm, the breaker will remain open until the resistance increases or until the feeder is locked out by a timing relay after remaining open continuously for several minutes.

Power for the control operations is supplied by 60-cell lead storage batteries installed in each substation. These are "floated" across a shunt-wound generator, which is driven from the low-voltage a-c network supply.

THE NEW RECTIFIERS

The rectifiers installed in the Village and Greeley substations are of the ignitron type, which consists of a separate tube or tank for each anode circuit. The selection of this type of rectifier was based on successful operation of similar equipment previously installed at 143d Street in Queens.

This type of rectifier has many advantages for rapid transit service. First, it has very high operating efficiency. This is inherent because of the relatively short arc stream between cathode and anode as compared with the multianode type of rectifier. A second advantage accrues from the fact that the ignitron is made up of an assemblage of individual tubes. If any of the tubes fail other tubes may readily be substituted. This would tend to reduce the outage time of a rectifier resulting from failure or breakage of any of the major parts. Third, the single-tube type of rectifier is easier to cool because tube dimensions are small and copper tubing may be brazed to the outside of the tank to provide the necessary cooling. The fourth point of advantage is that, being made up of a number of small component parts, these rectifiers are easier to handle in the limited space of small underground substations.

The rectifiers on the Sixth Avenue line consist of two rows of six tubes each, mounted on a steel framework. The vacuum pumping apparatus is located at the center of the structure, and vacuum manifold and water manifold are mounted between the two rows of tubes. The vacuum manifold is water-cooled and is provided with a mercury trap at each tube location. The water manifolds are run at the top and bottom of the tubes and cooling water is supplied to the copper cooling coils of each of the tubes in parallel. Each tube is equipped with a manually

Interior of one of the newest cars in use on the Independent Division of the New York rapid transit system, with seat upholstery of plastic material; note subdivision of car into four sections, each served by a pair of doors on either side

operated vacuum valve. If it is necessary to remove a tube, closing all these vacuum valves would prevent losing vacuum in the remainder of the tubes.

As each tube is equipped with a copper cooling coil, there is no necessity for using treated water to prevent corrosion. The customary heat exchanger which is used with multianode tanks therefore is omitted; and although a recirculating scheme of cooling is used, this merely consists of a pump which forces water rapidly through the cooling pipes insuring uniform temperature distribution throughout the length of each tube and uniform flow through all of the tubes. The necessary raw cooling water to hold the proper temperature is admitted from the city mains as required. Surplus water overflows to the sump.

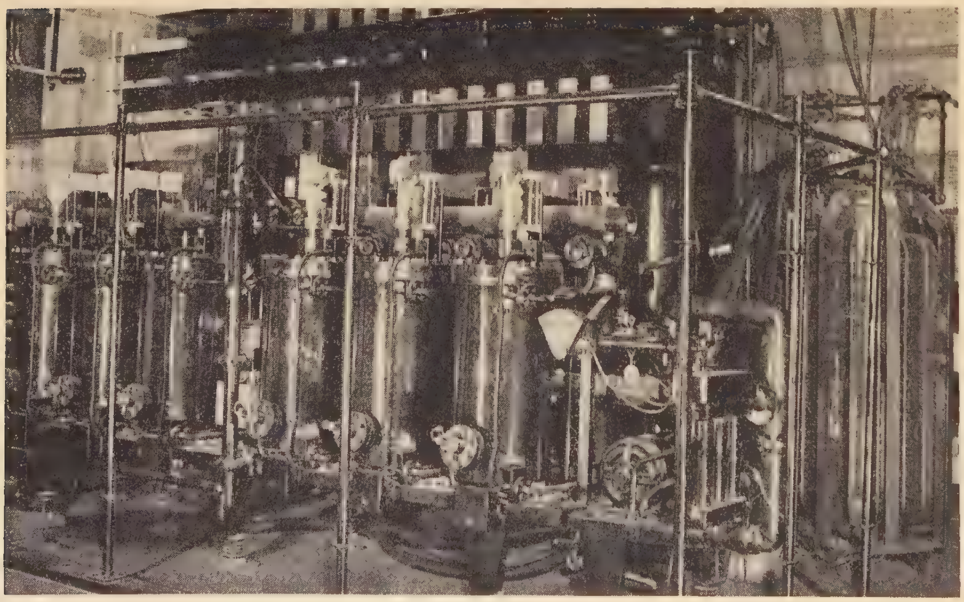
The rectifier tubes are made up of seamless steel drawn cylinders closed at one end and with a flange added at the other end to accommodate a cover. The mercury of the cathode is placed at the bottom of the tube, and as the arc is not continuous while the tube is operating, no cathode insulation is required. A steel separator around the outer edge of the mercury pool serves to catch dirt and particles of material washed down on the sides of the tube. The igniter which dips into the center of the mercury pool is carried by an insulated rod fastened to a flexible diaphragm mounted on a flanged opening in the side of the tank. Adjusting screws are provided so that the immersion of the igniter in the mercury pool may be accurately controlled without breaking the vacuum. Above the cathode is a baffle to prevent mercury splash from the cathode being carried to the anode. The anode and the anode baffle are mounted on the detachable cover, and both are constructed of graphite. All electrical circuits enter the vacuum chamber through Mycalex insulators.

The operation of the ignitron type of rectifier has been described in a number of technical papers.[9,10] There are, however, various means of controlling the igniter circuit. In the present case, the capacitor type of firing circuit is employed. This circuit employs a transformer for supplying the necessary power to the igniter circuit with correct phase relationship, a capacitor which is charged from this transformer, an auxiliary vacuum tube for releasing current to the igniter at the proper point in the cycle, and limiting resistors. It is necessary for the igniter to fire and start the power arc each cycle. At the end of the tube conducting period the main arc goes out and no other arc exists within the tube until the arc is again started when the main anode again should start to conduct.

The necessary firing equipment consisting of auxiliary vacuum tubes, capacitors, resistors, supply transformers, and a voltage regulator is mounted in a separate cubicle. The voltage-regulating equipment insures proper excitation through a range of supply voltage from 20 per cent below to 10 per cent above normal. The auxiliary vacuum tubes are mounted in two rows of six in the cubicle and "bull's-eyes" in the cover over the tubes provides visual indication on the operation of all tubes.

The quadruple zigzag 12-phase transformer connection is used to supply power to the rectifier. This connection uses two 180-cycle interphase transformers and one 360-cycle interphase transformer.

A relay gives indication over the supervisory system at the dispatcher's office in case of failure of one of the ignitron tubes to fire properly for any cause. This failure might be caused by a faulty igniter or a defective auxiliary vacuum tube. The rectifier may operate with 11 anodes firing, or may be shut down by the dispatcher, as he prefers. Operation on 11 anodes causes considerable distortion in the a-c supply and in the d-c output. Therefore, it is preferable to correct this condition as soon as possible. Provision is made to facilitate a rapid change from 12-phase operation on the complete transformer to 6-phase operation on half of the transformer. This may be accomplished by simply removing six of the fuses from the firing circuit. The rectifier may be operated indefinitely at half its rating using the 6-phase connection.



One of the four 3,000-kw 625-volt ignitron-type rectifiers installed to furnish propulsion power for the Sixth Avenue subway; each of the 12 tanks of this 12-phase rectifier contains a single anode

Other equipment in these stations follows very closely the practice of previous New York Board of Transportation installations. High-voltage a-c circuits are completely enclosed with metal-clad switchgear. Control panels are all of the cubicle type.

THE NEW CONVERTERS

The 4,000-kw synchronous converters installed on the Independent System in 1930 are said to have been the largest 60-cycle converters built for railway use up to that time.[5]

The highly satisfactory operating record of these machines led to the selection of the same type of unit for the increased capacity required in the Central and Greenwich substations. However, operating experience and progress in the art have suggested several improvements which have been incorporated in the new machines.

The earlier machines were equalized at the commutator end of the armature, once for each armature slot or once every four commutator segments. The new machines also are equalized at the commutator end, but have an equalizer connection for every commutator segment. This increase in equalization will still further improve commutation and short-circuit performance.

The brush rigging used with the previous machines employed fiber insulating collars and sleeves for insulating the brush bracket arms from the supporting yoke. This construction provided adequate insulation and mechanical strength; but as the fiber changed due to changes in humidity and temperature conditions, occasional tightening of the supporting bolts was required. Molded Mycalex insulators are used in the new machines, simplifying the construction and at the same time providing strong permanent insulating joints. Mycalex insulators are not affected by humidity, have smooth surfaces which do not collect dirt, thus maintaining good creepage insulation, and are very resistant to the action of an electric arc.

Another innovation in the new converters is the elimination of the pilot brushes. Converters of this type are started with the main brushes raised off the commutator. Pilot brushes are left in contact with the commutator during the starting period to supply an indication of polarity and to provide current for exciting the shunt field. Before the converter reaches synchronous speed, the voltage between commutator segments short-circuited by the pilot brushes varies continuously with the slip position of the armature, and as a result considerable short-circuit current circulates between these segments through the brushes. This causes the familiar flashing and sparking of these brushes during the starting period, resulting in burning of the commutator and rapid wearing of the brushes. This sparking may also result in throwing small particles of material over the adjacent main-brush tracks in the commutator, resulting in a loss of commutator film and possible poor commutation from the main brushes. Synchronous-converter commutators often are ground or turned solely because of the burning caused by the pilot brushes during starting.

The elimination of the pilot brushes necessarily involved a change in the starting sequence of these automatically controlled machines. The starting sequence with pilot brushes is normally as follows:

1. Apply starting voltage to converter slip rings (main brushes off the commutator).
2. Obtain an indication of synchronous speed by the appearance of voltage across the pilot brushes.
3. Separately excite the converter shunt field for a definite time to insure polarity.
4. Remove separate excitation and make field self-excited, using current supplied from the pilot brushes.
5. Transfer from starting voltage to full voltage on the converter rings.
6. Place main brushes on the commutator.
7. Connect converter to d-c bus.

It may be noted that machine potential as supplied by the pilot brushes is used in operations 2 and 4. This potential is also used for a number of checks during starting sequence.

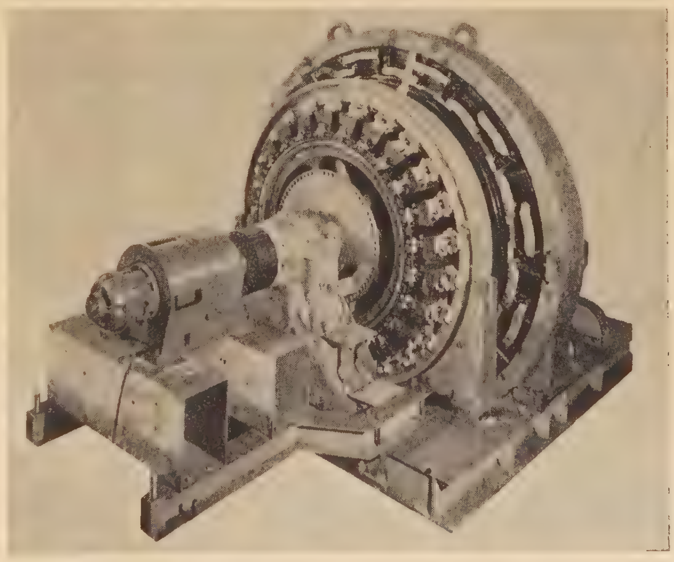
When the pilot brushes of the converter are eliminated the starting sequence must be correspondingly changed:

1. Apply starting voltage to the converter slip rings (main brushes off the commutator).
2. Indication of synchronous speed as determined by a reduction in starting current.
3. Separate excitation of the converter shunt field.
4. Transfer from starting voltage to full voltage on the converter rings.
5. Place brushes on commutator.
6. Change from separate to self-excitation.
7. Connect the converter to the d-c bus.

Adequate time delays and checks are used at various points, as required, in either sequence.

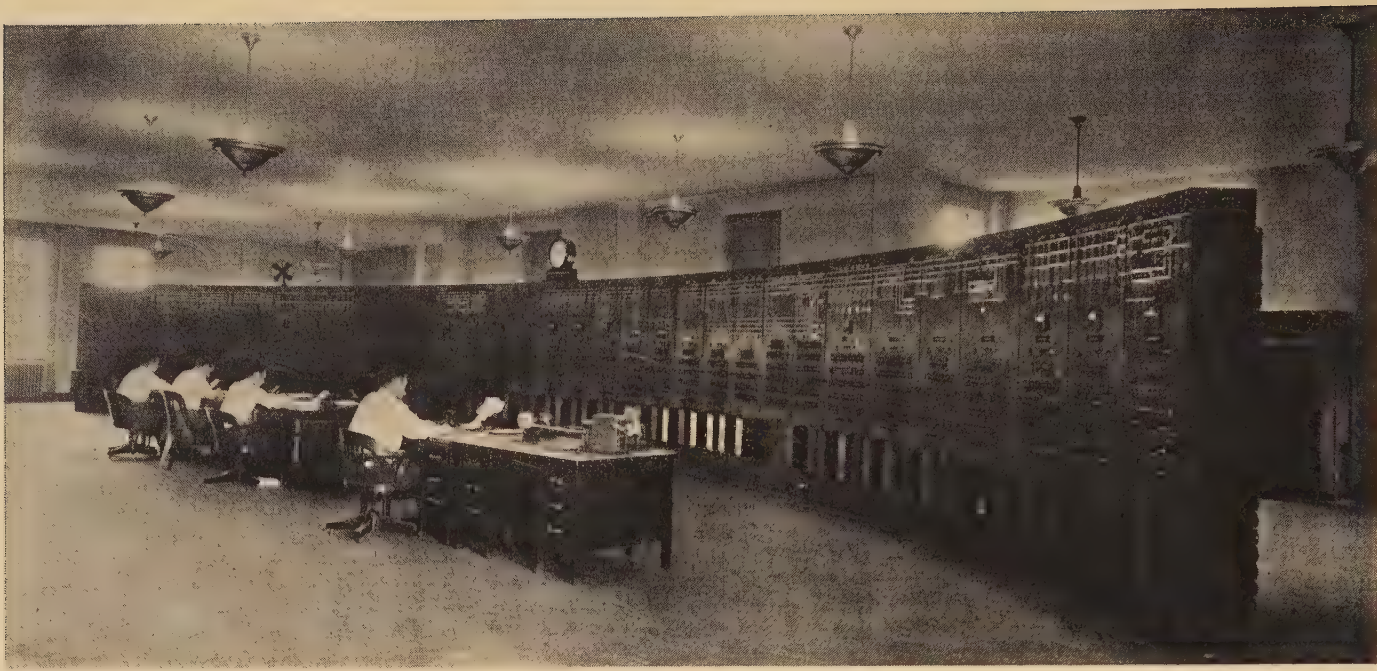
With the present machines the separate source of excitation is the 125-volt substation control battery. The converter shunt fields are divided into two parts which are supplied in multiple from this source.

Another interesting feature of these machines is the method of ventilation employed. The armature and field frame of each unit is enclosed in a volute housing. The armature acts as the impeller of a blower. Air is taken in through the armature spider and discharged to



One of the three 4,000-kw 300-rpm 625-volt 60-cycle 12-phase synchronous converters installed in existing substations to supply propulsion power for the Sixth Avenue subway

Coupled to the left end of the machine is the newly designed armature turning gear to expedite inspection and repair of armature and commutator. Shown also is the barring gear by means of which the armature may be turned by hand by inserting a bar in one of the holes of the disk attached to the shaft at the left end of the armature spider, and exerting pressure against the fulcrum mounted on the side of the bearing pedestal



From this board in the central power dispatcher's office are controlled all substations on the entire Independent Division of the New York rapid transit system, including those newly installed to serve the Sixth Avenue line

the volute housing. From these housings the air is carried in a duct on the ceiling of the basement to one end of the building. A vertical duct then discharges the air through the roof. With this scheme of ventilation no fans or blowers are required, and in addition recirculation of hot air through the machines is prevented. Forced ventilation of the stations is materially reduced over that required with open machines.

The converters are completely equipped with flash barriers which tend to prevent commutator flashovers by providing a high degree of isolation between positive and negative brushes and from brushes to ground.

SIGNALING

Signaling on the Sixth Avenue line is typical of the latest development in subway signaling under the most congested conditions. Signals are provided for ten-car operation at 90-second headway, with 30-second stops at local stations and 45-second stops at express stations. To maintain this headway, particularly through the congested sections between 34th and 50th Streets, it has been necessary to use the "station" timing feature to a large extent and add signals accordingly. The station timing feature provides means to permit trains to follow into stations, at reduced speeds, with reduced braking distance between trains without loss in safety. Also there are sections where "grade" timing is necessary, because of the relatively steep grades and sharp curves. The grade timing feature provides that trains must run at a predetermined speed on descending grades and at other points where excessive speed would create dangerous conditions.

The Independent Division signaling is of two basic types: electropneumatic and all-electric.[11,12] The essentials of both are the same, in that a train shall be protected by braking distance between it and the preceding train at all times, and in that through interlocked switches a completed route for a train, once set up, shall be held by an approaching train, and all conflicting switches and signals locked, until the train has passed completely over that interlocked section of track.

The chief differences between the electropneumatic and the all-electric systems are that air at a pressure of approximately 60 pounds per square inch controlled by electromagnets is used to operate the switches and automatic train stops of the electropneumatic system, while electricity exclusively is used to control and operate the switches and stops of the all-electric system. A 2-inch air line with compressors and automatic air-pressure control is incidental with the electropneumatic system, and a 130-volt storage battery and rectifiers with the all-electric system. Other minor differences exist on account of the different design of the interlocking machines and controls, such as the use of battery indication with the electropneumatic switch to show that the switch operated and locked up properly; and a dynamic indication on the all-electric switch.

Track circuits are of the a-c single-rail type, in which one running rail, called the signal rail, is used exclusively for the track circuit. The other rail is used in common by the signal track circuit, and by the propulsion current return circuit. The average length of track circuit is about 400 feet, minimum length being 100 feet, and maximum 1,000 feet.

Automatic block signals are of the "permissive" type where a red light indicates that a train must stop and then proceed prepared to "stop within vision." The automatic stop arm at each automatic block-signal location,

which enforces recognition of stop indication, is automatically lowered by the train stopping at the block signal.

Interlocked home signals are of the "absolute" type where two red lights indicate that a train must "stop and stay." The automatic stop at each interlocked home signal is not lowered by the train stopping at the signal. Interlocked home signals consist of two three-light units, one above the other, with a single yellow-light unit below. The light indications in the upper unit give to the motorman of a train the same information as the regular automatic block signal regarding the condition of the "block" ahead. The lower three-light unit indicates to the motorman by green or yellow lights the route on which the train will proceed. "Green" indicates straight or main route and "yellow" indicates diverging route. The bottom single yellow, designated the "call-on" signal, is sometimes displayed below the two red lights to indicate "stop and then proceed with caution" and "prepare to stop within vision." This call-on indication requires that the motorman operate a top release key, located alongside the interlocked home signal, to lower the automatic stop arm before train can proceed, thus providing co-operation with the towerman in order to pass an interlocking home signal.

Where route selection is not necessary or where the signal does not control passage over switch points or frogs, interlocked approach signals are used in order not to give a "stop and stay" indication of the interlocked home signal. These signals are the same in indication and control as the automatic block signal except that they are lever-controlled from the interlocking machine and mechanically and electrically lock the switch or switches within their control limits.

Two interlocking machines have been installed on the Sixth Avenue line, one at 34th Street station and one at Fourth Street station. Some important details concerning these and the interlocking machines installed throughout the entire Independent Division are given in the accompanying tabulation.

Interlockings Installed on Independent Subway

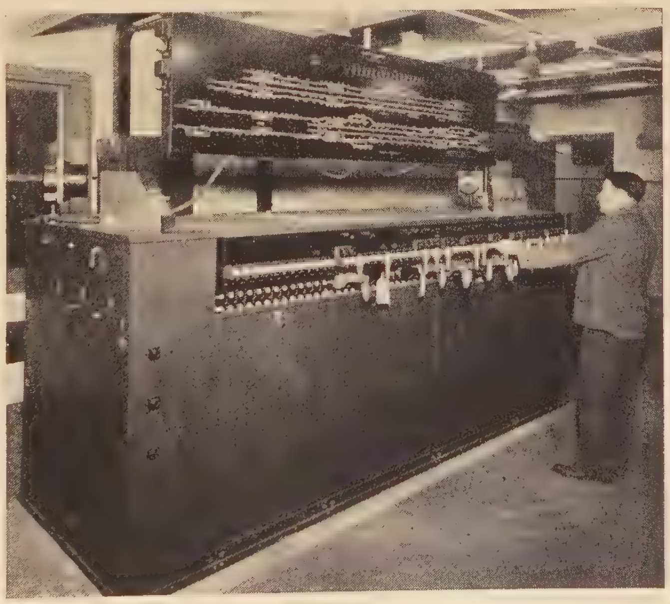
	Size of Frame	Working Levers	No. of Switches	No. of Inter-locking Signals	No. of Auto-matic Train Stops
6th Avenue line—					
34th St.	68	55	20	42	45
W. 4th St.	56	35	12	34	35
49 machines previously installed on Independent lines	1,861	1,471	657	1,326	994
51 machines on all Independent lines	1,985	1,561	689	1,402	1,074

Power for signaling is obtained from two points on the low-voltage a-c Consolidated Edison network system at each passenger station. Insulating transformers of approximately one-to-one ratio, one on each source of power, with an automatic changeover switch provide normal and reserve power at all times to the signal-power mains.

The signal-power mains are run in ducts or on messenger cable throughout the system. In order to sectionalize these mains in case of power interruption, and to reduce the effects of electrostatic capacitance, the mains are installed in sections of less than one mile in length. Each section of mains is a complete unit in itself.

Potential relays assure changing over of power to reserve supply if normal supply is interrupted or before a dangerous low voltage is reached. Manual reset back from reserve to normal power is provided to avoid any floating of contacts between normal and reserve control should voltages fluctuate. One very important requirement of these change-over switches is that they must operate and the signal main power must be restored in a maximum of three cycles, or 0.05 second, in order that no interruption to the signal circuits shall occur while transferring energy from the normal source to reserve source or vice versa. Any open circuit or low voltage on either of the normal or reserve power supplies is indicated by a light at each source and by a light and alarm bell in the nearest signal tower for a series of sources.

Protection is provided against grounds and electrostatic capacitance by a low-resistance connection from the negative main to ground through a low-resistance winding of a double-element relay. Normal electrostatic capacitance current from the positive main to ground completes the circuit and normally energizes this low-resistance winding of the double-element relay. The high-resistance winding is energized locally from the mains in series with a fixed capacitor. Any control wire that becomes grounded has its relay or other control apparatus protected from electrostatic potential. Any grounded positive wire or equivalent insulation weakness will disturb the phase relationship of the two windings of the double-element relay, open its front contacts, and close an added low-resistance path to ground over back contacts, shunting the relay, holding it down, and giving additional protection while the ground remains. Grounds are indicated by light



Interlocking signal board at the West Fourth Street station; indicator board at top shows locations of all trains in entire section covered by this board

indicators locally, and by light indicators and an alarm bell in the nearest interlocking control tower. The relay must be manually reset when the ground is removed.

Typical grade-time and station-time signal control circuits have been described previously.[12] Grade-time controls may be one- or two-block clearing as may be necessary, although two-block clearing is most ideal and is used wherever possible and practical.

The all-electric track switch-operating and dynamic-indication circuit is used with a magnetic brake to hold the track switch in the last operated position should energy be removed for any reason. In addition, a polarized switch repeater circuit indicates that switch movement, switch points, and switch operating lever are all in unison before signals can be given for a route over the switch.

ILLUMINATION

Stations of the Sixth Avenue subway are illuminated at an intensity of about two foot-candles throughout, except on stairways and platform edges, where the intensity is higher. Illumination is furnished throughout both stations and tunnels by 120-volt incandescent lamps connected in groups of five in series for operation on 600 volts. Energy for lighting is obtained from the 120-volt a-c network of the Consolidated Edison Company, a step-up transformer being required at each point of supply to furnish energy at 600 volts. The use of 600-volt lighting circuits permits use of the third rail as an emergency source of supply at comparatively low cost. Furthermore, this arrangement was less expensive to install than multiple lighting, even including the step-up transformers.

Power for lighting normally is supplied through two transformer rooms located at either side of each station. These transformers are supplied from separate direct feeders from the low-voltage network. About half of the station platforms, stairways, and passageways is lighted from each transformer, so that in case of failure of either source about half normal illumination will remain throughout the station. Should both sources fail, the lighting circuits may be connected directly to the third rail circuit by means of transfer switches in the transformer rooms.

Between stations, each track of the subway is illuminated by two lines of lamps, one on each side; the lamps in the two lines are "staggered" and spaced approximately 80 feet apart. One line is supplied from the adjacent station in one direction, and the other line from the adjacent station in the other direction. In case of failure of power on either circuit, an automatic transfer switch will connect the circuit to the other transformer of the same station. This switch automatically returns to normal position upon restoration of power. Like the station lighting, the tunnel lighting may be connected to the third rail in case of emergency, by means of a transfer switch.

MISCELLANEOUS ELECTRICAL APPLICATIONS

Among other electrical or electrically driven equipment used in the subway are: ventilating fans, moving stairways, drainage pumps, and entrance turnstiles. Normally, the movement of trains through the tunnels provides a sufficient circulation of air. When train operation is interrupted, however, and particularly when there is smoke, forced ventilation becomes necessary in the deep tunnels. For this purpose, fan chambers have been provided to house exhaust blowers of sufficient capacity to change the air in the adjacent sections of the subway approximately every 15 minutes. These blowers are of various capacities, ranging up to 140,000 cubic feet per minute, under pressure of approximately two inches of water. The entire emergency ventilation system is remote controlled from the power dispatcher's office on 53d Street. In addition, the fans in any particular section of the subway will be started whenever the emergency alarm in that section of the subway is operated.

Pump chambers are located at all low points in the subway with sumps of capacities of about 7,000 gallons each. Standard equipment for these pump chambers consists of three pumps, one having a capacity of 1,000 gallons per minute, and two with a capacity of 200 gallons per minute. Each pump is driven by an induction motor, and is automatically controlled by means of float switches.

Telephone service for the Sixth Avenue subway, as for the rest of the Independent Division, is furnished from a private branch exchange connected to the New York Telephone Company system. A telephone switchboard and associated equipment is situated in the building on 53d Street which also houses the power-control equipment for the entire system. Telephones are located in all change booths, substations, rectifier chambers, signal towers, dispatchers' offices, circuit-breaker houses, pump rooms, and other enclosures where necessary, and also throughout the length of the subway at intervals of about 600 feet. At each of the latter locations, there also is an emergency alarm pull box, the purpose of which is to cut off power from the third rail in the immediate area. The locations of these telephones and alarm boxes are indicated by blue lights.

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Standard Basic Impulse Insulation Levels

This report of the joint committee* on co-ordination of insulation of AIEE, Edison Electric Institute, and National Electrical Manufacturers Association is the culmination of more than ten years' study to establish basic insulation co-ordination. It specifies basic impulse insulation levels in terms of a withstand voltage for a specified test wave. These values are to be the bases for various AIEE and other standards now in course of development or revision.

CULMINATING over ten years' work on insulation co-ordination during which the fundamentals of making impulse tests were investigated and standardized, as well as basic levels set up and provisionally tried out, the joint AIEE-EEI-NEMA committee on insulation co-ordination at its meeting held in November, 1940, agreed unanimously to adopt as standard the series of basic impulse insulation levels given in table I. These are the same values given in the paper presented at the AIEE winter convention, January 22–26, 1940, "Basic Impulse Insulation Levels" by Sporn and Powel (*AIEE Trans., Oct. '40 Sec., p. 596–8*). The purpose of this present report is to call attention to the fact that these basic levels have now been adopted and to the general conditions under which they apply.

The general principle of insulation co-ordination requires a reasonable margin between the voltage level held by the protective device (the protectable level) and the various basic levels themselves to insure that adequate protection is provided. The values in table I have been set up on this basis. It is felt that the values so set up are on a sound basis and that they are most likely to stand without change for a long time. It is the opinion of the committee, therefore, that the various technical committees working on standards can adopt the values given in this report for standardization purposes, and it is further believed that the use of these values will result in ultimate over-all benefit to the industry.

When first formed, the joint committee adopted as a statement of principles the following:

"The co-ordination of insulation involves three steps:

1. Establishment of insulation levels.

2. Specification of insulation strengths of all classes of equipment in established impulse levels.

3. Allocation of the insulation levels to the nominal system voltages, taking into account all operating and environmental conditions."

The adoption of the standard insulation levels in table I of this report completes the first step of the committee work.

DEFINITION OF BASIC IMPULSE INSULATION LEVELS

To clarify the meaning and intent of the levels which are given in table I, it may be well to mention here two fundamental definitions. It is believed that these definitions and the associated comments clearly indicate the requirements of any apparatus which is built to these levels and is reported as conforming to them.

"BASIC IMPULSE INSULATION LEVELS

"Basic impulse insulation levels are reference levels expressed in impulse crest voltage with a standard wave not longer than 1.5×40 microsecond wave. Apparatus insulation, as demonstrated by suitable tests, shall be equal to or greater than the basic insulation level."

This requires that apparatus conforming to these levels shall have a withstand value not less than the kilovolt value given in the second column of table I. It is also understood that apparatus conforming to these requirements shall be capable of withstanding the specified voltage whether the impulse is positive or negative in polarity.

"WITHSTAND VOLTAGE (FOR AN IMPULSE)

"The withstand voltage of a test specimen under an impulse of any given wave shape, polarity, and amplitude, which does not cause disruptive discharge on the test specimen, is the crest value attained by that impulse."

EXCEPTIONS TO TABLE I

Taking cognizance of the fact that some apparatus insulators do not at the present time fully meet the levels given in table I, the committee recognized certain exceptions. These exceptions apply to insulation levels 150, 200, and 250 kv but only for switch and bus insulators and apparatus employing these insulators, with the understanding that after January 1, 1943, all equipment will meet the values given in table I. Any new or modified designs of such apparatus completed prior to that date should, of course, conform to the values given in the table. This exception further definitely states that it will exist as an exception only until January 1, 1943, after which no equipment will be excepted from meeting the requirements of table I if such equipment is represented as meeting "Standard Basic Impulse Insulation Levels."

Table I. Standard Basic Impulse Insulation Levels

Reference Class (Kv)	Basic Impulse Level (Kv)
1.2	30
2.5	45
5.0	60
8.7	75
.....	95
15	110
23	150*
34.5	200*
46	250*
69	350
92	450
115	550
138	650
161	750
196	900
230	1,050
287	1,300
345	1,550

* For switch and bus insulators, and apparatus such as air switches and power fuses employing these insulators, the levels of 150, 200, and 250 kv shall become effective on January 1, 1943, with the understanding that any redesign or modification of such equipment completed earlier than January 1, 1943, shall be made on the basis of 150, 200, and 250 kv levels. In the interim and for existing designs of this equipment, values of 145, 190, and 240 kv will be recognized as exceptions for these three classes, respectively.

NOTE: Attention is called to the fact that equipment carrying a power-frequency voltage rating which is numerically the same as the "Reference Class" in table I is not necessarily required to have the corresponding impulse level given in the table. Decisions in this regard are provided for in the two remaining steps mentioned above in the committee's original statement of principles.

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Report presented informally at the AIEE winter convention, Philadelphia, Pa., January 27–31, 1941.

Automatic Control of Aircraft

C. D. BARBULESCO
MEMBER AIEE

A method of controlling aircraft through electromagnetic radiations is described here in which the controls are preset and the aircraft is flown and landed on a predetermined course in any kind of weather conditions. The operation is entirely automatic and the presence of a control operator is not needed. The solution of this problem was made possible by the development of two novel aids for fog navigation and fog landing, namely, the aircraft radio compass and the ultrahigh-frequency marker beacon.

THE problem of remote control of aircraft was initiated at the end of World War I. Due to lack of stability of the airplanes and the primitive status of aircraft radio at that time, the first attempts were not very successful. In the last few years, however, the great advance in both aviation and aircraft radio made the solution of this seemingly difficult problem quite simple.

Two methods have been successfully developed. In the first method the control operator sends into space a definite number of electromagnetic impulses using an ordinary telephone dial. It is obvious that if the operator is on the ground the radius of action of such a device is quite limited, because the airplane must remain in full sight of the operator all the time. In order to increase the range of this aerial torpedo, it is necessary for the control operator to follow it in another airplane.

It is possible, however, to navigate a pilotless airplane over a predetermined course of considerable span, and to land it safely at the end of its journey. This operation can be rendered entirely automatic; it can be performed in any weather conditions and without the presence of a control operator.

Six devices of novel design have brought about the success of such an enterprise. The first is the automatic pilot, which maintains the airplance in proper flying attitude. The second device is the aircraft radio compass, which is capable of controlling the rudder of the airplane through the automatic pilot, and thus can direct the aircraft toward a desired guiding radio station on the ground. The third device is the ultrahigh-frequency marker beacon, which is associated with the radio guiding station. As soon as the airplane arrives over the guiding station this device acts as an invisible finger which reaches through the space and automatically dispatches the airplane toward the next predetermined guiding radio station. In this manner the airplane can be flown automatically over a row of control stations arranged in a straight line or in any desired course.

The fourth type of equipment developed is an altitude control mechanism, and the fifth is a power control device. Finally it was necessary to develop an interlocking electromechanical system in order to co-ordinate and synchronize the automatic landing operation.

A paper presented: (1) at the AIEE Middle Eastern District meeting, Cincinnati, Ohio, October 9–11, 1940; and (2) at the conference on air transportation, AIEE winter convention, Philadelphia, Pa., January 27–31, 1941.

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A more detailed description of the theory and operation of these devices is necessary before analyzing the technique of the automatic landing of aircraft.

ATTITUDE CONTROL

The Artificial Horizon. The airplane is a free body in space having six degrees of freedom, three translational and three rotational. In figure 1, an airplane is represented with reference to three axes in space. The translations occur along the X axis (forward motion); along the Y axis (sidewise motion); and along the Z axis (up or down motion). The rotational or angular degrees of freedom are: rotation about the X axis (bank), controlled by the ailerons; rotation about the Y axis (pitch), controlled by the elevators; and rotation about the Z axis (turn), controlled by the rudder.

For each degree of freedom there are instruments and radio devices informing the pilot of not only the amount of motion, but of the rate of motion as well. The development of these instruments and radio devices made the problem of blind navigation and blind landing much easier than anticipated.

Using only a radio compass for direction, two marker beacons for position, and a sensitive barometric altimeter corrected by radio for altitude, Major A. E. Hegenberger executed on May 9, 1932, the first complete solo blind takeoff and landing at Patterson Field, Ohio. This experiment was not a stunt, because it was followed by thousands of blind landings executed by hundreds of other Army Air Corps pilots at various fields using the same type of equipment.

The attitude of the airplane in these landings was maintained with the artificial horizon, and the turns were

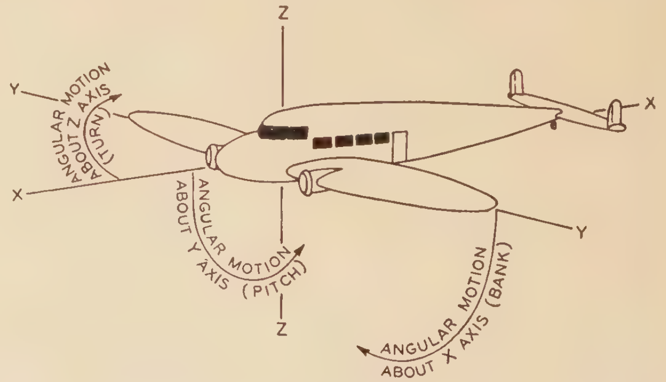


Figure 1. The airplane as a free body in space, illustrating its translational and rotational degrees of freedom

executed using the directional gyro. These gyroscopic instruments are vital in fog flying and landing.

The purpose of the artificial horizon is to provide a fixed reference for maintaining flight control in fog. In clear weather the pilot uses the natural horizon *as reference.* In fog the artificial horizon provides a substitute for the natural horizon. A small airplane is painted in silhouette on a dial in front of a pointer bar, which is connected to a gyroscope spinning about a vertical axis. As the airplane banks, climbs, or dives, the silhouette does likewise, but the pointer bar, being actuated by the gyro, remains horizontal. Under foggy conditions it is only necessary for the pilot to keep the silhouette in line with the bar and parallel to it in order to maintain flight attitude.

The Directional Gyro. A magnetic compass is worthless in fog on account of violent and amplified oscillations, produced as soon as the pilot attempts any kind of turn. These oscillations will not disappear until after the airplane has resumed a straight course. The directional gyro allows the pilot to keep a straight course and thus to stabilize the magnetic compass after executing a turn in fog.

On this instrument the sensitive element is a concentric card divided into 360 degrees. The pilot observes the card in relation to a lubber line and thus obtains an accurate index of turn. The card is maintained in fixed position in space by a gyro spinning about a horizontal axis. With the help of this instrument, 180-degree turns can be executed in fog with the greatest of ease.

The Automatic Pilot. In automatic flight the gyroscopic elements of the artificial horizon and the directional gyro actuate the controls of the airplane and keep it in level flight and on its course. The relative movement between the gyros and their casing is converted by means of air pick-offs and air relay systems, into movements of a hydraulic servo unit which in turn provides power for moving the controls. The horizontal gyro controls the ailerons and elevators while the directional gyro controls the operation of the rudder.

AZIMUTH CONTROL

The Aircraft Radio Compass. With the aid of the radio compass the pilot can fly toward a known radio station on the ground. This device comprises a vertical nondirectional antenna, a receiving loop mounted perpendicular to the longitudinal axis of the airplane, a balanced modulator, a conventional aircraft radio receiver, and a right-and-left indicator.

By simply maintaining the needle in zero position the pilot can head the airplane toward a control station or away from it. In order to eliminate the 180-degree ambiguity, the radio compass is disposed so that, when flying toward the station, if the pilot steers to the right the needle deflects to the left. When flying away from the station, if the pilot steers to the right the needle also deflects to the right. In both cases the needle deflects toward the station side and shows the pilot in what direction to turn in order to head the airplane toward the control station.

This versatile radio device was developed in Germany by Doctor Dieckman in 1926, and perfected in the United States by Air Corps engineers. It is of great value for fog navigation and fog landing, thus increasing the efficiency and safety of the airplane.

Figure 2 shows a simplified circuit of a modern aircraft radio compass. As long as the airplane flies toward the radio station the plane of the loop is parallel to the magnetic lines of force of the radiated field and there is no electromotive force induced in the loop. The needle of the indicator remains at zero until the airplane is steered to the right or to the left. It is obvious that the electromotive forces induced in the loop, when its normal takes two symmetrical positions with the course, are 180 degrees out of phase.

The balanced modulator compares these phases in the two coils of the electrodynamometric type of indicator. As may be readily seen from the simplified diagram, the fixed coil is fed directly with the low-frequency current generated by the modulator, while the moving coil receives the rectified component which modulates the incoming carrier.

The Air Corps experts have succeeded in developing means of causing the right and left movements of the radio compass indicator to correct the directional gyro in the automatic pilot in order to maintain the true heading of the airplane toward a radio transmitting station. By means of this connecting link, the pilot can fly to his destination merely by tuning the radio compass to a radio station located in the vicinity of his landing field.

An elegant solution of this difficult problem was offered by Major Carl Crane of the Air Corps in 1935. The principle of operation may be readily understood from figure 3. The direction of rotation of a minute reversible air turbine is controlled by an air vane carried by the movement of the radio compass indicator. The shaft of the turbine operates through a system of gears, a single-pole double-throw switch, reversing the current in the field windings of a differential d-c series motor. This servo motor in turn controls the air pick-off device of the directional gyro of the automatic pilot. Thus the rudder

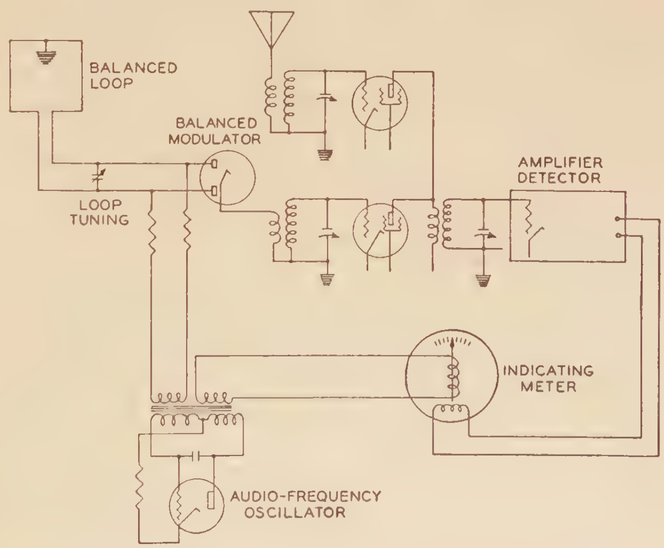


Figure 2. Simplified diagram of the radio compass

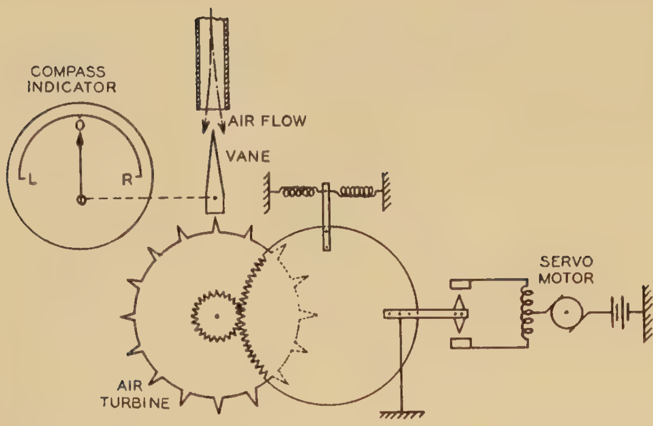


Figure 3. The directional relay controlling the rudder from the output of the radio compass

is automatically operated until the needle of the indicator returns to zero position and through the air vane stops the air turbine. At this moment the airplane is headed toward the control station.

The Ultrahigh-Frequency Markers. The pilot can determine well enough when he arrives over the control radio station from the reversal of the indications in the radio compass. A better and more positive indication is provided by the ultrahigh-frequency marker. In contrast with the radiation pattern of the radio control station which is omnidirectional, the radiation pattern of the ultrahigh-frequency marker is highly directional.

There are two types of ultrahigh-frequency markers, the fan and the "Z" type. Both operate on 75 megacycles and radiate into space either a fan-shaped electromagnetic beam or an inverse cone of electromagnetic energy. The fan-shaped beams are used mainly across the radio range courses as distance indicators, or parallel to the boundary of the landing field for fog landing purposes. The "Z" markers are used in conjunction with the radio range stations to fill the cone of silence and give a positive indication to the pilot when he arrives over the station. This indication is in general a flash of light on the instrument board.

In the Air Corps systems of blind landing and automatic landing, the fan-shaped markers are associated with the control stations and the fan-shaped beam is directed across the path of approach of the aircraft negotiating the landing. Two control stations define the approach for manual landing in fog, while at least four control stations are needed for automatic landing.

The theory of the ultrahigh-frequency markers is simple. The projector comprises a conventional ultrahigh-frequency oscillator operating at 75 megacycles and feeding a horizontal doublet or half-wave antenna, located a quarter wave above a reflecting surface. The energy reflected is in phase with the energy radiated by the doublet and builds a fan-shaped beam across the path of the aircraft.

On the aircraft a similar doublet, tuned to 75 megacycles is installed under the fuselage along the longitudinal axis. This doublet is coupled to a conventional ultrahigh-frequency receiver, which operates a relay. In figure 4 the shape of the beam is indicated in a horizontal and vertical plane. The combined effect of the transmitting and receiving directional doublets produce a much sharper virtual beam indicated in dotted lines. The relay remains closed and the indicating light flashes only during the time the airplane passes through the virtual beam.

The Control Stations. Each control station comprises a conventional medium-frequency transmitter feeding a nondirectional vertical mast antenna, and an ultrahigh-frequency marker-beacon projector. The doublet antenna of the marker projector is oriented parallel to the direction of flight and throws a curtain of electromagnetic energy across the path of the airplane.

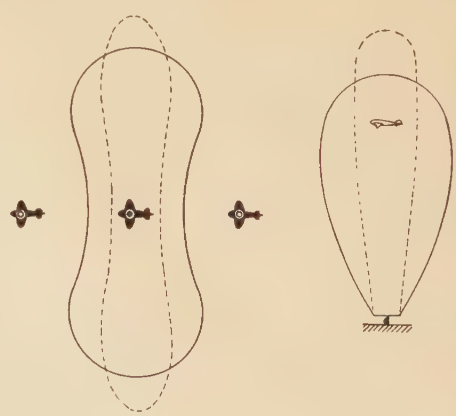
The range of frequencies of the medium-frequency transmitter is 200 to 400 kilocycles. This band is actually used for aerial navigation purposes. The frequency of the marker beacon has been standardized at 75 megacycles by the Army, the Navy, and the Civil Aeronautics Administration.

In figure 5 the disposition of the control stations for automatic landing is shown. Obviously they are aligned in the direction of flight, the landing being negotiated against the wind. The furthermost station, number 1, is approximately 15 miles from the landing field. Station number 5, located across the field, controls the heading of the airplane during the last phase of the landing operation. Each nondirectional transmitter has a different frequency while all the ultrahigh-frequency marker transmitters operate at 75 megacycles.

The Automatic Dispatcher. This device constitutes the brains of the automatic flight and landing operation. It comprises a marker-beacon receptor, a selector switch, and an automatic tuning device, operating the radio compass. In figure 6 a simplified diagram shows clearly the principle of operation.

The energy received by the marker-beacon receptor from the marker-beacon projector, actuates a relay, which advances the selector switch one step. The arm of the selector closes the corresponding contact and sends current into the armature and one of the field windings of a differential series motor, actuating the tuning of the radio compass. The angular position of the selective cams in the automatic tuner is so adjusted on the shaft that the current is automatically cut off in the motor when the radio compass is tuned to the radio control sta-

Figure 4. The actual and the virtual (dotted) beam of an ultrahigh-frequency marker beacon in horizontal and vertical planes



tion toward which the airplane is headed. This is done by insulated fingers riding on the edges of the cams controlling the position of the arms of the single-pole double-throw spring switches.

On the tuning shaft there are as many selective cams as control stations on the ground. Each is adjusted for the automatic tuning of the compass to the corresponding control station when the sweeping arm of the selector switch closes the corresponding contact.

As described hereinbefore, the output of the radio compass actuates the rudder of the airplane through the automatic pilot, and the airplane is flown toward and over any control station. When arriving there, the energy received from the marker beacon advances the selector switch one step further, and immediately the radio compass is tuned to the next control station. In this manner the airplane may be promptly dispatched from point to point over a row of stations defining any desired course.

The Automatic-Landing Technique. The automatic landing is negotiated as follows: Assume that the airplane is flown at an altitude of 1,000 feet within the range of station 1. The radio compass is tuned to this station and the airplane is automatically flown toward it. Arriving over station 1, the airplane enters the field of the marker-beacon projector associated with it. The selector switch advances one step and tunes the radio compass to the frequency of station 2. Now the airplane flies automatically toward this station, gradually directing its flight into the wind following the alignment of the stations.

Arriving over control station 2, the selector switch advances one step further and the compass is tuned to station 3. When over station 3, the contact not only causes the tuning of the compass to station 4 but also closes another circuit actuating the throttle control. This control is identical with the automatic tuner of the radio compass, using a cam preset for a position of the throttle corresponding to a glide of about 400 feet per minute.

Over station 3 the airplane therefore starts to glide into the field, and if there is no wind, arrives over station 4 at an altitude of about 200 feet. Passing over station 4, the compass is again switched to the frequency corresponding to station 5, located on the other side of the field,

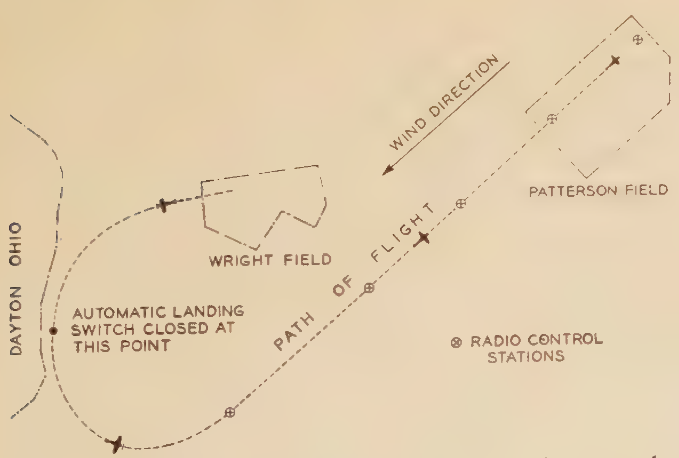


Figure 5. Practical arrangement of radio control stations for automatic landing

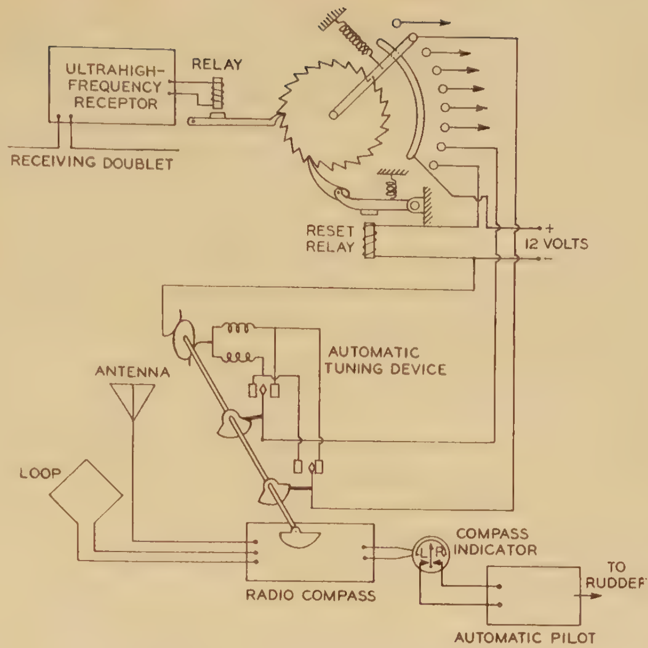


Figure 6. The automatic dispatcher

and the airplane maintains the proper heading into the wind until the wheels touch the ground. The impact produces a displacement of the component parts of the landing gear closing a switch which closes the throttle. After rolling over the ground for a little while, the tail drops, and the airplane automatically comes to a complete stop.

ALTITUDE CONTROL

In conditions of strong wind the glide is much steeper and the airplane might land before crossing the boundary of the field. In order to prevent this a small mirror is glued to the hand of the barometric altimeter. When the hand reaches a position corresponding to a minimum safe altitude of 200 feet, the mirror picks up a beam of light which is reflected upon a photoelectric cell. The output of the cell actuates a relay closing the circuit which operates the throttle, setting it in forward position for level flight. When the airplane arrives over the control station 4, located at the boundary of the field, the selector switch again actuates the throttle control setting it for normal glide.

EXPERIMENTAL RESULTS

Early in 1935 Lieutenant (now Major) Carl J. Crane of the Air Corps planned the development work at the Materiel Division that led to the accomplishment of the first entirely automatic landing of an airplane on August 23, 1937. During 1935 Major Crane was assisted by Major G. V. Holloman, Mr. R. K. Stout and the author, and through their joint effort the various components of the automatic landing system were designed, built, and finally installed in a single-engined Fokker airplane which was used exclusively for the initial flight research, most of which was conducted by Major Holloman. Mr. Stout and the author were charged with most of the design and

engineering of the electromechanical elements of the automatic landing system and finally, after some two years of constant flight and laboratory research, the first entirely automatic landings were accomplished.

About 25 automatic landings were negotiated with various Army officers riding in the airplane as observers. In spite of the unfavorable weather conditions, the landings were executed without any difficulty, proving beyond doubt that the problem was solved, although much was left to be done to insure the high order of reliability demanded by present standards of air safety.

The pilot observer was instructed to take off manually from Wright Field and to fly the airplane at an altitude of about 1,000 feet. The control stations were located at Patterson Field, about six miles from Wright Field. When the airplane was still in the range of the control station situated the farthest from the field, a master switch was closed by the pilot who was instructed to let the controls alone and merely observe the automatic landing process from then on. In order to increase the confidence of the observer in the automatic controls, a parallel row of contacts, associated with the selector switch, flashed lights revealing the identity of the control station toward which the airplane was flying at any particular moment.

POSSIBLE APPLICATIONS

One of the first possible applications of this development is to relieve the modern pilot of many routine physical duties. When a pilot can see the ground, the amount of information he receives through his senses is amazing. When flying in conditions of poor visibility he must gather and integrate this information from scores of instruments displayed before him. The time element, however, is not very important in fog flying, and considerable tolerances are allowable in many of the pilot's tasks.

In the process of landing in fog, however, both time and space are at a premium. The pilot actually needs his information with greater accuracy and he must integrate and interpret it very rapidly, in order to act without risk of confusion. The automatic device described relieves the pilot of the continual strain of maintaining the airplane in flight. His responsibilities become broader, watching the condition of the ship and engines, obtaining weather information through radio, and keeping in contact with the traffic dispatchers.

The possible military applications of this development are left to the imagination of the reader. With nominal additional development it will be possible, in the near future, to cause an airplane to take off, to continue in automatic flight on a predetermined course, and then to land automatically at a predetermined place, entirely without human control.

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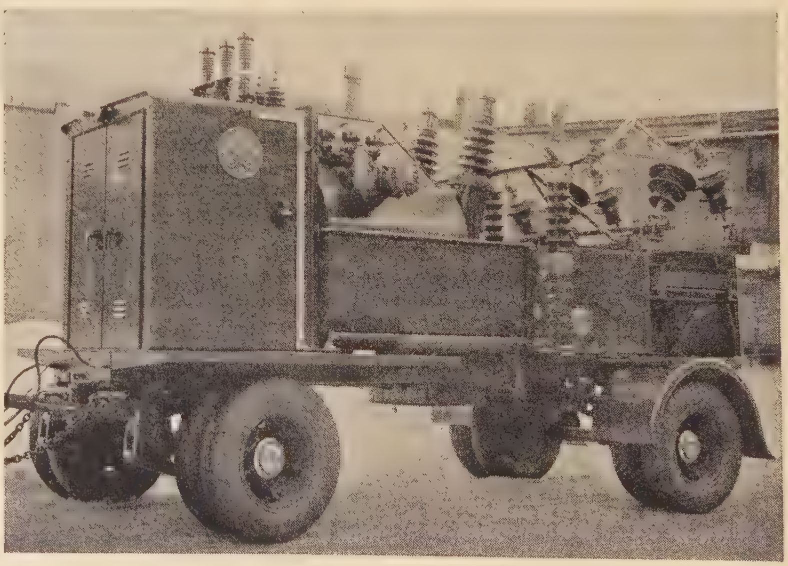
3. Aircraft Radio and Electrical Equipment (book), **Howard K. Morgan.** Pitman, 1940. Chapter IX shows complete diagrams of modern aircraft radio compass.

Mobile Substation for Emergency Power Supply

FOR quickly supplying or restoring power in a serious emergency, this completely factory-built 1,000-kva mobile substation has been built for the Central New York Power Corporation at Syracuse, N. Y., by the General Electric Company. The unit is mounted on a special chassis and can be hauled at speeds up to 40 miles per hour. Over-all dimensions, including extensions, are 11 feet 6 inches high, 21 feet long, and 8 feet wide; the height can be reduced to 9 feet 10 inches for low clearances. Total weight, including chassis, is almost 10 tons. Use of a forced oil cooling system permitted the substation to be built in compact weight and size.

The substation consists of one three-phase 1,000-kva transformer, with primary and secondary switching equipment and lightning arresters. It is designed to take power from high-voltage lines of 11, 13.2, 22, 33, or 44 kv, transform it, and supply it to systems of 230, 460, 2,300, 4,000, or 4,600 volts. Installation is merely a matter of parking and grounding the unit; attaching incoming high-voltage lines to one side; and the secondary system lines supplying the customers to the other side. In addition to emergency service, the mobile substation also will be used to by-pass regular substations while repairs are being made or while maintenance work is being done, thus preventing interruption of service.



Institute Activities

Draft and Overdraft

A Message From President Sorensen

AMERICA'S program of National Defense is the prevailing topic of conversation and discussion encountered by your president in his travels about the country in the discharge of his duties of office. Last fall the question most commonly encountered was: "What is being done in other parts of the United States for National Defense?" Currently the prevailing question is: "What are we going to do to get enough engineers to assure maintaining the production required in the Defense program?"

We are now enormously overdrawing our available supply of engineers. Not only are all available experienced engineers now employed, but this spring's graduating engineering students are practically all engaged for positions in industry or for Army or Navy engineering work immediately upon graduation. In fact, if every one of the 150-odd engineering colleges had senior classes triple the size of those that will graduate this spring, the present demand indicates that a shortage of qualified engineers and designers still would exist for the work the nation now has before it.

Engineers are not kept in storage for use in emergencies like those now current. The Defense program now in progress indicates that the 1942 demand for engineers will be as great as if not greater than the one now facing us. A continuing supply of high-quality men for engineering work must be available without interruption both for civil and military Defense operations. These engineers and other technical experts cannot be produced quickly—by legislation or mere wishful thinking—but become qualified for the rigorous requirements of their work only through a long period of educational preparation followed by years of practical experience. The more precise the work required, the more specific and thorough must be the training of the engineer to do that work.

What are we going to do to assure this necessary and continuing supply of engineers?

First and most important, not knowing for how long the acutely vital Defense program must continue, we must be prepared to augment our present supply of engineers through the medium of a program of education and training of qualified young men that will assure a supply to meet the demand. Not only must current new demands be met, but account also must be taken of the vacancies caused by superannuation, retirement, and death of the older members of the profession.

Next, because of the present great preponderance of demand over supply, it is our first duty to assure that men qualified to do engineering work are not assigned to or permitted to assume Defense duties that can be performed by persons not qualified by education and training to do engineering work. It is the duty of every engineer to aid his local Draft Board in honestly analyzing the relative need for engineers in every type of service, in classifying every drafted man according to his technical training and ability, and in placing the men where they will be most effective in the over-all National Defense program. In some instances such a basis for selection would mean retention in civilian engineering service; in all instances it could avoid waste or misapplication of the limited supply of available technically trained and experienced man power by avoiding the assignment of engineers to duties that do not require engineering knowledge. This would be of great value in the present situation.

As to the future, present indications are such as to give prominence and great importance to the question of what to plan for men now in their junior years at engineering colleges. Many of these young men are anxious to undertake their period of military service immediately. Others are being sorely tempted to drop—or at least to interrupt—their college training to answer industry's call for man power. Either of these moves would meet the present situation at the expense of later and probably at least equally vital needs for technically trained men. Pending the development of further data on these important matters, we well may consider the advisability of having engineering students now in good standing in engineering colleges continue their studies; at least until we can be more certain that the present overdraft of engineers for the production of needed defense equipment will not result in a future lack of men with minimum preparation for good engineering in industry. (That minimum preparation is deemed to be graduation from an approved course of study at an engineering college.) Such a deferment of military service already has been made for those engineering students who will complete their planned college courses by July 1, 1941. It seems logical to consider the need for extending such deferment to include students now in good standing in engineering schools who can complete their planned educational program by July 1, 1942, and who otherwise might be selected by a local Draft Board for military service prior to that date. The engineering colleges now are considering a program for accelerating the education of student engineers by omitting summer vacation periods, and by such other procedures as may be developed.

AIEE SECTIONS MIGHT HELP

Our present Draft law leaves in the hands of local Draft Boards all decisions on points such as those we have discussed in the foregoing. Although these local boards have full control of the selection of men for military service, or for their deferment, these boards cannot with maximum efficiency make many of the decisions concerning the disposition of engineers unless engineers are willing to help the boards determine with fine discretion how, and when, and where engineers of draft age best and most effectively may serve both the present and the probable future needs of National Defense. Therefore, it would seem reasonable to suggest that each Institute Section might greatly

Inspecting the Edison dynamo that was installed on the S.S. Columbia in 1880 (see page 105) and is now at the Edison Institute Museum, Dearborn, Mich., are left to right, J. W. Bishop of the Museum staff, National Secretary H. H. Henline, President R. W. Sorensen, and A. W. Meyer, Detroit Edison Company

aid the National Defense program by giving immediate and effective co-operation to local Draft Boards. With reference to practicing engineers, such co-operation could include assistance in proper classification for both military and nonmilitary Defense needs. With reference to students, such co-operation could include providing local Draft Boards in their respective localities with a record of places where engineers are needed and with something of a parallel record of student engineers being developed to fill those needs.

In any event, let's not overdraw our supply of engineers to a point below that at which we assuredly can keep our Defense program on a strong and continuing basis.

As this "message" is written your president and national secretary are in the midst of a tour embracing a large part of the United States, visiting Institute Sections and Branches, and endeavoring to meet as many as possible of the Institute's members. This is the second such tour that has been made since the current administrative year began last August.

The first tour was synchronized with the Middle Eastern District meeting at Cincinnati, Ohio, October 9–11, 1940, and included visits to 10 Sections and 7 Branches. That first tour ended November 1. This present tour of visitation will end February 17 and was scheduled to include the 1941 winter convention at Philadelphia, and visits to 14 Sections and 8 Branches. With the record-breaking registrations of 599 at the District meeting in Cincinnati, and 1,931 at the winter convention in Philadelphia, together with the membership represented by the various Sections and Branches visited, your president and national secretary have on these two tours at least exposed themselves to a total of some 5,500 persons active or interested in AIEE affairs, and have made at least something of a contact with a large proportion of these people. Indeed one of the smaller Sections reported 14 immediate new applications for membership and several more pending for attention. Also, this Section now plans to hold monthly instead of bimonthly meetings as heretofore.

Analysis of Registration at Recent Winter Conventions

District	1938	1939	1940	1941
Middle Eastern (2)...	292...	404...	412...	946
New York City and foreign (3)..........	767...	752...	743...	523
North Eastern (1)....	252...	287...	332...	276
Great Lakes (5)......	74...	76...	76...	122
Southern (4).........	11...	16...	22...	27
Canada (10).........	14...	28...	20...	12
South West (7)......	18...	37...	10...	2
Pacific (8)...........	5...	4...	6...	12
North West (9)......	3...	2...	3...	3
North Central (6)....	2...	4...	2...	8
Totals.........	1,438...	1,610...	1,626...	1,931

Attendance at Special Features of Recent Winter Conventions

Feature	1938	1939	1940	1941
Total registration....	1,438...	1,610...	1,626...	1,931
Smoker..............	1,201...	1,264...	1,466...	1,420
Dinner-dance........	651...	527...	538...	730
Inspection trips......	1,012...	1,167...	1,700...	1,055

Philadelphia Convention Sets Record; G. E. President Challenges Industry

WARNING his listeners that the American free-enterprise system—in fact the whole democratic way of life—is in imminent peril of being lost in one way or another through the present world-wide upheaval, Charles E. Wilson, president of the General Electric Company, speaking January 29, at the 1941 AIEE winter convention, urged prompt, thoughtful, and courageous action by American industry and all liberty-loving individuals. Mr. Wilson urged realistically that the mirage of the hoped-for "return of normal times" be discarded as a goal, before it has led its self-blinded followers too far, and he challengingly presented as a basis for discussion a proposed program of step-by-step action for a more probable future. The full text of this thought-provoking address appears elsewhere in this issue.

SORENSEN INTRODUCES WILSON

Presiding at the general session Wednesday morning, January 29, at which Doctor Robley D. Evans, Massachusetts Institute of Technology, was the other featured speaker, President Royal W. Sorensen introduced Mr. Wilson in these terms:

"The defense program as I understand it has its foundation in our desire to have America and such other parts of the world as may be possible continue to be places where men are free to do the things that are exemplified by the lives of many of us participating in this convention program. This morning we listened to Doctor Robley D. Evans, a physicist who, before the age of 35, received a medal for distinguished work in physical sciences. Our American freedom and equality of opportunity for all provided the ways and means for Doctor Evans without money or influence of any kind to earn his way through college and to have opportunity to gain the ability he showed us today. This evening we have on our program several others about whom we could say the same thing, but we also have with us outstanding men who, without the advantages of college courses, have by the practice of diligence in work and the building of character under our American way of life been granted the privilege of achieving great things.... These men all started work as office boys in their early teens; they all once were shipping clerks, foremen, superintendents, engineers, managers, and vice-presidents. They all are interested in the betterment of the workers in their plants, and are active members of churches. ...A chairman of the board of General Electric Contracts Corporation, a chairman of the board of the Monowatt Corporation, a chairman of the General Electric Vacuum Cleaner Company, a vice-chairman of the board of the General Electric Supply Corporation; directors of the General Electric Company, the Edison General Electric Appliance Company, the Trumbull Electric Manufacturing Company, and the International General Electric Company. These men are Charles E. Wilson, president of the General Electric Company."

ATOM SMASHING AND MEDICINE

Doctor Evans, a Nobel laureate, opened the Wednesday morning session with an illuminating address entitled "Atom Smashing and Its Application to Medicine." Doctor Evans' address is scheduled for publication in ELECTRICAL ENGINEERING as soon as a manuscript can be made available. His able treatment succeeded admirably in bringing the highly technical topic down

In addition to hotel and meeting-room lobbies, the winter convention committee took over and specially fitted the Bellevue-Stratford Hotel's "Planet Room" to serve registration purposes and as general convention headquarters. Below at right is shown the women's lounge and the operating center of the trips committee. In the general view, below at the left, the main registration desk is at the left, the novel registration bulletin board (see facing page) in the center background, and a portion of the men's lounge at the right

out of the stratosphere of human understanding.

EDISON MEDAL PRESENTATION

At a general session held Wednesday evening, with appropriate ceremony, President Sorensen presented the Institute's Edison medal to Doctor George A. Campbell, retired research engineer of the Bell Telephone Laboratories, for 1940 "in recognition of his distinction as scientist and inventor, and for his outstanding original contributions to the theory and application of electric circuits and apparatus." Chairman L. W. W. Morrow of the Edison medal committee, outlined the history and significance of the award, and Past President Doctor Frank B. Jewett sketched the career and contributions of the medalist. Doctor Jewett's address and Doctor Campbell's response may be found elsewhere in this issue; a brief biographical sketch of Doctor Campbell was given on page 30 of the recent January issue.

REGISTRATION SETS NEW RECORD

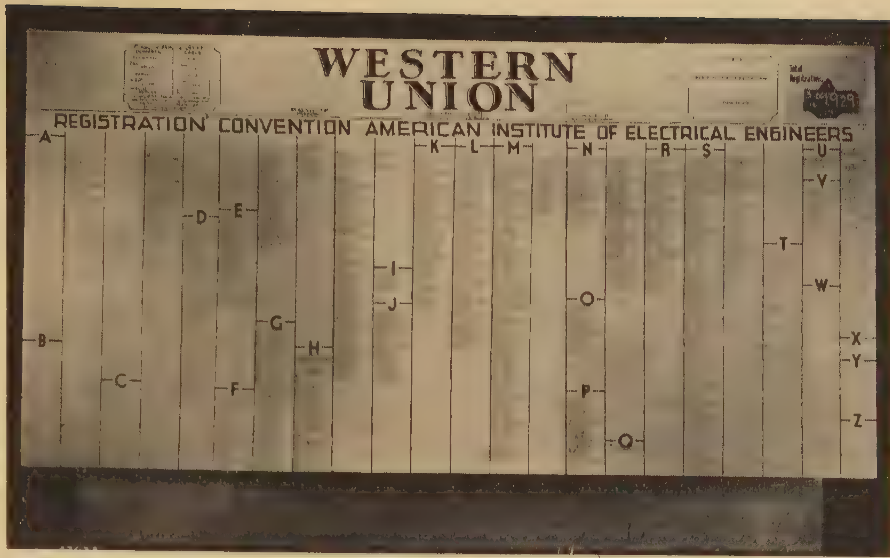
With a verified registration totaling 1,931, the 1941 AIEE winter convention set a new all-time high mark for winter convention registered attendance. The convention was held at the Bellevue-Stratford Hotel in Philadelphia, January 27–31 under the sponsorship of the Philadelphia Section. This is the first time that the winter convention has been held outside New York City since 1924, at which time it also was held in Philadelphia—with a registration of 1,738.

Continuing the trend toward broader technical programs, the convention this year included 20 technical sessions and 9 technical conferences, compared with 18 and 8, respectively, last year. The regular technical sessions accommodated the presentation and discussion of 82 technical papers; 4 scheduled conference papers and numerous informal progress reports and discussions were accommodated in the technical conferences.

ENTERTAINMENT AND INSPECTION TRIPS

The two principal social events were the traditional dinner-dance and smoker, supplemented by a women's dinner-and-bridge party which paralleled the men's smoker. The dinner-dance attendance, 730, establishes a new record, the previous highest figure having been 651 in 1938; the smoker attendance, 1,420, is a close second to the 1940 record of 1466. For the women, the local committee's generous program of trips and special affairs provided three full days of activities, Monday having been left open. For the men, a dozen regularly scheduled inspection trips were provided. Comparative attendance figures for principal convention events are given in one of the accompanying tabulations.

Among the special gatherings of different groups during convention week were an informal dinner meeting of Rutgers alumni, an informal dinner meeting of Columbia University electrical engineering alumni, and the annual dinner of Eta Kappa Nu celebrating the society's annual recognition of outstanding young electrical engineers (*EE, Jan. '41, p. 42 and 52*). Reports of other convention-week events appear on the following pages.



Related novel and effective features of winter-convention registration were a teletypewriter installation operated from the registration desk which gave a visible display of each name as it was transcribed at a receiving stand onto a standard tape, and the 8-by-12 foot display board shown above, onto which each name was stripped immediately

Analysis of Attendance at 1941 Winter Convention

Classification	Philadelphia	Districts 2*	1	3	4	5	6	7	8	9	10	Foreign	Totals
Members	307	297	218	396	19	100	4		9	2	11	1	1364
Men guests	110	80	36	85	4	15	1		1		1	1	334
Women guests	113	39	22	40	4	6	3	2	2	1			233
Totals	530	416	276	521	27	122	8	2	12	3	12	2	1931

* Outside of Philadelphia Section territory.

Some High Lights of Convention Conferences and Committee Meetings

An increased number of technical conferences and meetings of most of the Institute's standing committees contributed to the interest of the 1941 winter convention at Philadelphia, Pa., January 27–31. The nine technical conferences were on the following subjects: air transportation, communication networks, electronic inverters, fluorescent lighting, new electrical aids in biological and medical research, nonlinearity in electrical machine problems, power distribution in industrial plants, Canadian and United States standards, and use of electricity in processing metals.

In addition to the regular meetings of the board of directors and the national nominating committee, both reported elsewhere in this issue, the following Institute committees met during convention week: air transportation, automatic stations, basic sciences, communication, domestic and commercial applications, education, electrical machinery, electrochemistry and electrometallurgy, instruments and measurements, Lamme Medal, land transportation, legislation affecting the engineering profession, lightning arrester subcommittee of the protective devices committee, membership, networks subcommittee, planning and co-ordination, power generation, protective devices, research, safety, Sections, standards, standards co-ordinating committees 4 and 6, technical program, transformer subcommittee. The usual luncheon for Student Branch counselors was held Thursday, January 30, and the District prize paper chairman met Tuesday, January 28.

Such high lights of general interest as were reported from these meetings by the chairmen follow.

CONFERENCE ON AIR TRANSPORTATION

The conference on air transportation, held January 29, was opened with the presentation of the papers on "Application of Electric Power in Aircraft", by T. B. Holliday, U. S. Army Air Corps; "Automatic Control of Aircraft", by C. D. Barbulesco, Antioch College; and "An Electrical Engine Indicator for Measuring Static and Dynamic Pressures", by E. J. Martin, C. G. Grinstead, and R. N. Frawley, General Motors Corporation. Following the presentation of these papers, a

general discussion was held on d-c versus a-c electric power supply systems for aircraft. The discussion led to the following conclusions:

1. A-c electrical systems for aircraft will probably not be specified for several years, or until a suitable means for maintaining constant speed at the input shaft of the main-engine-driven alternator despite variations in the speed of the main engine has been developed.

2. The use of auxiliary power plants for other than "stand-by" purposes in flight, or to supply electrical energy when the airplane is not in flight, is not practical from a minimum weight standpoint. The primary source of electric power for airplanes in flight will be from main engine driven generators on the airplane.

3. Due to intensive development, and design improvements in main-engine-driven generator design, airplanes in the future will probably be arranged with minimum battery capacity and all electric power in flight to be supplied from the main engine generators. This conclusion was based on the fact that approximately 45 pounds of generator can supply 120 amperes continuously at 28.5 volts, as compared to approximately 160 pounds of storage battery capable of supplying 120 amperes at approximately 18 volts for only 20 minutes.

4. The high operating speeds of a-c high-frequency motors will probably lead to considerable bearing lubrication and maintenance difficulty, and require a large reduction gear box in order to get output speeds suitable for most airplane applications, the weight of the reduction gear box in many cases offsetting the reduction in weight of the motor attained through high motor revolutions per minute.

It was further concluded that most large airplane electrical systems will be of the 24–28.5 volt d-c type with possible future development toward a 120 volt d-c supply system for very large airplanes with large operating electrical power requirements.

The meeting was attended by approximately 200 AIEE members from various government services, colleges, and electrical and aircraft manufacturing companies. (*E. E. Minor, chairman, air transportation committee.*)

CONFERENCE ON COMMUNICATION NETWORKS

A sixth annual informal conference on network analysis and synthesis, sponsored by the AIEE committee on communication, was held January 31. Three subjects were presented and discussed. "Operational and Moment Analysis of Transient Distortion in Networks," was presented by Roy C. Spencer, The University of Nebraska, and presentations of "The Repeater-Transformer, a Generalization of the Transformer Concept as Applied to Feedback Amplifiers," and "The Zero-Frequency Carrier or the Vector Envelope in the Solution of Unsymmetrical Sideband Problems, Such as Single-Sideband Transmission or Frequency Modulation" were made by Harold A. Wheeler, Hazeltine Service Corporation.

The attendance this year was very considerably less than at previous meetings (about 40 as compared to almost 200 last year). There may have been several reasons for this, a significant one being the fact that the convention this year was held in Philadelphia instead of New York, with the result that many who are only mildly interested in this subject were eliminated. As a result, the effectiveness of the meeting was greatly enhanced, and those present were greatly pleased by the resulting informality and consequent free interchange of ideas.

It was the opinion of a number of those present that the invitations in future years should be restricted to a more seriously interested group of this sort so that the same group feeling which was responsible for the success of this year's meeting may be maintained. It is the chairman's opinion that this objective is well worth serious consideration. (*Ernst A. Guillemin, chairman of the conference.*)

CONFERENCE ON ELECTRONIC INVERTERS

At the conference held January 28, 1941, the subject of electronic inverters was opened by Doctor S. B. Ingram, of the Bell Telephone Laboratories, who pointed out that in view of the fundamental similarity of inverters and rectifier circuits and the wide use of the latter, it is surprising that more inverter applications have not been found. In the informal discussion which followed it was brought out that there are a number of problems encountered in inverters which are not met in rectifiers or which occur in much less severe form. One of these is the problem of commutation. Another is the dependence of output and of circuit behavior in general on variations in magnitude and reactance of the load. Several practical inverter applications were briefly described and discussed. It was the consensus of the conference that the field of practical use of electronic inverters was necessarily limited, but that these devices had a definite field of usefulness where conditions of operation were suitably chosen. Tube life in both inverter and rectifier circuits was discussed and it was pointed out that tube operating conditions could be made as satisfactory in inverters as in rectifiers if attention was given to suitable circuit design. Experience from one large inverter installation in a d-c transmission system was cited to show that highly satisfactory tube life could be obtained under inverter conditions of operation.

Approximately 40 attended. Those participating in the discussion included S. B. Ingram, V. L. Holdaway, and D. E. Trucksess of the Bell Telephone Laboratories; W. C. White, M. S. Mead, and C. W. La Pierre of the General Electric Company; W. E. Pakala of the Westinghouse Electric and Manufacturing Company; Professor C. H. Willis of Princeton University; Professor B. K. Northrop of Cornell University; Professor A. A. Nims of the Newark College of Engineering; A. J. Williams of Leeds and Northrup; W. Richter, consulting engineer; and others. (*H. M. Turner, chairman of the conference.*)

TECHNICAL SESSION AND CONFERENCE ON FLUORESCENT LIGHTING

Under the sponsorship of the committee on production and application of light, a technical session and conference on fluorescent lighting were held on the afternoon of January 29. D. W. Atwater, chairman of the committee, acted as chairman of both.

Two papers were delivered at the Technical Session: "Fluorescent Lighting Fills the Gap", by A. A. Brainerd, and "Developments of the Glow Switch", by R. F. Hays.

Mr. Brainerd pointed out the importance of considering all factors involved in lighting design before selecting any of the modern light sources. He indicated that such factors as size of fixtures, concentration of light source, efficiencies, and cost must be given proper weight in any design. Hence, the promiscuous application of fluorescent lighting, because it is new and different, is a very dangerous procedure, although it has not been unknown since the introduction of the fluorescent lamp. The analysis of the advantages and disadvantages of the three principal light sources in modern illumination—the incandescent lamp, the high intensity mercury vapor lamp, and the fluorescent lamp—was very enlightening and constructive.

In the paper on glow switches, Mr. Hays explains the underlying theory of the switch and the problems in its construction that had to be solved in order to make it a practical instrument. He pointed out the effect of various gases and gas pressures on starting time and indicated the importance of selecting the proper metal for coating the two electrodes within the switch. Curves and data were given indicating its operation under various conditions of voltage and with various electrodes and gases.

At the close of the technical session, Chairman Atwater opened the conference with a short statement concerning the rapid growth of fluorescent lighting during the past year and the effect it has had upon raising illumination levels in industry. He pointed out that in 1939 a survey indicated that the average level in industry was less than 10 foot-candles. Today, many of the larger installations are well above 30 foot-candles, some going as high as 60 and 100 for special operations. While such installations, according to Mr. Atwater, cannot be considered as general practice yet, undoubtedly, the introduction of the fluorescent lamp and its many advantages is rapidly bringing about such a condition.

O. P. Cleaver gave a summary of the most important advances in fluorescent lamps and auxiliaries during the past year. He demonstrated the new 100-watt *T*-17 fluorescent lamp, pointing out that it produced about twice the lumens per foot available from the former sizes of fluorescent lamps commercially available. This lamp, however, was slightly lower in efficiency than the 40-watt lamp and had a lower rated life of 2,000 hours.

The small 6-watt 9-inch *T*-5 fluorescent lamp was also shown with its control equipment. This lamp, while having been available for some time, nevertheless, has recently been changed from the former oval bulb type to the round *T*-5 bulb, and its life has been increased to 750 hours. Many applications have been worked out for its use, such as bed lamps, table lamps (at least four bulbs per lamp), cash registers, instrument boards on airplanes, and others.

The 14-watt 15-inch fluorescent lamp, designed to operate two in series with a small tungsten lamp as ballast, was demonstrated next, and its use in home lighting and train lighting explained.

Other advances during the year were listed as: the introduction of the new soft white which improves the appearance of certain raw meats and vegetables and enhances the appearance of the human skin; the improvement of ballast equipment due to better design and improvements in manufacturing technique; the availability of radio-interference correcting equipment; and the solution of the power-factor problem by the widespread use of the two-lamp ballast.

Mr. Cleaver pointed out that consider-

able research work was being done on the fluorescent lamp of today and that the future would undoubtedly see different sizes and improved lamp performance and efficiencies.

Following Mr. Cleaver's talk, A. B. O'Day discussed the many improvements that had been made in lighting equipment for the use of fluorescent lamps. He mentioned the fine work that had been done by the RLM Standards Institute, the Fleur-O-Lier Manufacturers Association, and others, in improving the quality of fixtures. He noted that a greater percentage of the fixtures is now properly shielded either with louvers or glass in the interest of eyesight conservation. As proof he showed several slides of more satisfactory installations of today. Mr. O'Day closed his discussion with a series of slides showing suggested designs of fixtures for the new 100-watt lamp and the other current types to indicate what the trend in lighting fixtures for fluorescent lamps may be in the future.

J. A. McDermott next introduced the subject of fluorescent-coated high-voltage tubing and its place in modern lighting practice. He showed several slides of its use at the New York World's Fair for decorative purposes and indicated that to date this had been its biggest field of application. He pointed out that with proper construction and manufacture, the tubes could probably be made as efficient as the low-voltage types for the same color. He indicated, however, that there was no particular control of the manner of construction and manufacture of these tubes throughout the United States, and hence efficiencies were likely to vary considerably, depending upon the manufacturing process. Mr. McDermott, in closing, stated that it was entirely likely that with present underwriters' regulations concerning high-voltage equipment in interiors, the high-voltage fluorescent tubing would be slightly more costly for general lighting purposes than low-voltage fluorescent lamp installations.

Following the discussion on high-voltage fluorescent tubing, Preston Millar gave a brief summary of 125 fluorescent lighting installations which had been selected as reasonably satisfactory by some 50 utilities throughout the United States The average foot-candles reported were 36 at the point of utilization and 28 foot-candles over-all. The power factor of these installations averaged above 90 per cent. The total wattage after the installation of fluorescent lighting was approximately 93 per cent of the former incandescent load. Daylight lamps predominated in the industrial installations, while daylight and white were about equally prevalent in all other types of installations.

Following the presentation of the prepared discussions, the conference was opened for discussion. The audience participated very actively and a number of subjects were brought up for consideration. Topics discussed included the importance of shielded fluorescent lamps for eye comfort; the necessity for considering measures to correct for radio interference; the possibilities of applying fluorescent lighting in the home; the characteristics that seem to appeal to the public, which in many instances have led to the purchase of fluorescent lighting at greater cost; the necessity for proper meter correction for measuring the new colors of fluorescent lighting; and further discussion of the cost of high-voltage fluorescent tubing for interior illumination. (*D. W. Atwater, chairman, committee on production and application of light.*)

NONLINEARITY IN ELECTRICAL MACHINE PROBLEMS

As a continuation of the general discussion of nonlinear analysis at the last summer convention the conference held January 28, concentrated on nonlinear problems connected with electrical machinery.

A. F. Puchstein, consulting engineer, Springfield, Ohio, presented the computation of current and torque in an a-c series—tool motor operating well over the saturation range of the magnetic characteristic. He substituted two straight lines for the saturation curve and introduced, at the boundary of the two regions, a correction to insure continuity of the power factor. This was very thoroughly discussed together with the question of whether or not a transient term should arise at that point. The discussion tended to support Mr. Puchstein's approach though it became rather evident that additional work is required to clear up this seemingly simple analytical treatment.

A very thorough presentation of the graphical analysis of the steady state and transient performance of saturated synchronous generators by Professor R. Rüdenberg of Harvard University followed. The elegance of the method and its applicability to both inductive and capacitive loads as well as the phenomenon of self-excitation so impressed the audience that it voted to request Professor Rüdenberg to prepare a formal paper for publication by the Institute.

Finally, Professor E. G. Keller of the University of Texas surveyed the rigorous analytical treatment of the pulling-into-step of synchronous motors, which, even without magnetic saturation, leads to complicated nonlinear differential equations. The first solution was obtained with the differential-analyzer at the Massachusetts Institute of Technology and Professor Keller demonstrated the direct analytical method, contending that any equation or system of equations solvable by mechanical means also can be obtained analytically. The interest in this new branch of advanced mathematics was evidenced by requests for references which Professor Keller has collected and systematically grouped over a period of years.

The attendance of about 40 prominent men from industry and universities demonstrated the value of conferences in this recently developed field of engineering research. (*Ernst Weber, chairman of the conference.*)

TECHNICAL SESSION AND CONFERENCE ON POWER DISTRIBUTION IN INDUSTRIAL PLANTS

The technical session and the technical conference on January 28 were devoted to the problem of power distribution in industrial plants.

Four papers were presented at the morning session, each dealing with a phase of this subject. C. A. Powel and H. G. Barnett of the Westinghouse Electric and Manufacturing Company discussed the merits of the network system for industrial plant distribution and urged further adoption of this system, particularly in the new defense industries. A. G. Darling, of the General Electric Company, Schenectady, N. Y., presented a "Short-Circuit Calculating Procedure for Low-Voltage A-C Systems". This paper included much useful and hitherto unpublished data of value to the engineer who is concerned with the design of low-voltage distribution systems. A paper dealing with the use of enclosed bus bar distribution systems for industrial plants, written by E. T. Carlson of the Trumbull Electric Manufacturing Company, Inc., Ludlow, Ky., was presented by Y. T. Chaney of the same company. A technical conference paper by R. C. R. Schulze of the Public Service Electric and Gas Company of Newark, N. J., on the subject of short-circuit calculations, dealt specifically with the problems encountered in designing industrial plant distribution systems.

The technical conference held in the afternoon attracted a considerable group of plant electrical engineers, utility power sales engineers, and others interested in the general subject. Several members of the industrial power applications committee were present and took part in the discussion. The general lack of reliable information and test data bearing on the performance of factory distribution systems was stressed. It was proposed that the committee should sponsor further papers on various aspects of this general subject and that, ultimately, a design manual for industrial distribution systems might be compiled and issued as a committee report or publication. (*J. J. Orr, chairman, committee on industrial power applications.*)

TECHNICAL SESSION AND CONFERENCE ON USE OF ELECTRICITY IN PROCESSING METALS

A technical session and conference on the use of electricity in processing metals were held Friday, January 31, under the joint sponsorship of the AIEE committee on electrochemistry and electrometallurgy and the American Society for Metals.

The papers presented at the technical session were "Large Electric Arc Furnaces—Performance and Power Supply" presented by B. M. Jones and C. M. Stearns of Duquesne Light Company, and "Electrolytic Process of Scale Removal From Steel" by H. W. Neblett of Inland Steel Company. Both papers were well received and actively discussed by those in attendance.

At the technical conference Doctor Paul Faragher of the Aluminum Company of America presented a paper on "Light Metal Alloys; Their Production, Fabrication, and Use". Doctor T. Holland Nelson presented a paper on "Stainless Steel and Its Production". There was a large attendance at the conference and both papers were enthusiastically received.

Committee Meeting. A meeting of the committee on electrochemistry and electrometallurgy was held on January 30, at which, in addition to routine matters, plans were discussed for a joint meeting with the Association of Iron and Steel Engineers, to be held at the Belden Hotel, Canton, Ohio, on May 27. The Cleveland and Pittsburgh Sections of the Institute are co-operating in working out plans for this meeting, which will include an inspection trip in the afternoon to be followed by dinner and an even-

ing technical session. (*W. C. Kalb, secretary, committee on electrochemistry and electrometallurgy.*)

STANDARDS ACTIVITIES

A technical session on rating of electrical machinery and apparatus and a technical conference on Canadian and United States standards, both on January 30, and meetings of the standards committee and standards co-ordinating committee 6 on January 28, and of standards co-ordinating committee 4 on January 29, all were held during the winter convention. Reports of some of these activities follow.

Conference on Canadian and American Standards. Feature of the conference was an address on "Wartime Standardization in Canada" by W. P. Dobson, chief testing engineer, Hydro Electric Power Commission of Ontario. High lights of this talk follow:

Standardization work in Canada is carried on by the National Research Council and the Canadian Engineering Standards Association. The former is concerned largely with industrial research but also prepares standards and specifications as a result of its research work, principally in the chemical and textile fields. The Canadian Engineering Standards Association is active in all other fields.

The publications of the Association may be divided into two groups: engineering materials and equipment, and regulations governing construction and operation which may form the basis of laws. Examples of the latter are the Canadian Electrical Code which has reached its fourth edition; and regulations governing radio interference, which are in the course of preparation.

An important responsibility recently assumed by the Association is the approval of electrical equipment sold or used under the Canadian Electrical Code. All approvals in Canada are now issued in the name of the Association; they are used by provincial inspection authorities in the enforcement of sales control regulations, which are in force in nearly all provinces.

The Association receives financial support from the National Research Council which also provides it with office space. Its other sources of revenue are the sale of its publications and subscriptions from industry. In 1940 it received slightly over 50 per cent of its financial support from industry. The approving of electrical equipment is carried on by a division whose finances are separated from the other activities of the Association, and which is entirely supported by the approvals fees received from manufacturers.

Both the Research Council and the Association are at present extremely active in war standardization work. The Council is carrying on many investigations and has prepared specifications for the purchase of a large variety of materials. A few examples are: camouflage nets; linings for bullet-proof helmets, preservative coatings for aircraft, military vehicles; specifications for shoe leathers; the substitution of cotton for linen in parachute harness webbing. It is also calibrating and testing gauges of all kinds.

The Canadian Engineering Standards Association, as a result of decisions reached in 1939 between the British authorities and the Canadian Mission to England, was asked to act as a liaison between the Canadian manufacturers and the British and Canadian governments in the supply of munitions. It performs three distinct services in this capacity: it supplies manufacturers with copies of British specifications and assists in their interpretation; it translates British Standards into Canadian and American practice; it receives from manufacturers and forwards to the Government suggestions for the substitution of Canadian and American standards in British specifications.

For these purposes it has organized since the beginning of the war three committees: on steel, aircraft construction, and electric wire and cable. These committees have saved a great deal of time for the Government and the manufacturers in that through the Canadian Engineering Standards Association it has been possible to co-ordinate the suggestions of the manufacturers and secure prompt consideration of them on the part of the Government authorities.

The American Standards Association and the Canadian Engineering Standards Association have always maintained close contact with each other, and with members of each serving on subcommittees of the other. The present emergency offers opportunities to both associations to assist in the harmonizing of standards and thus speeding up production.

Meeting of Co-ordinating Committee 4. AIEE Standards co-ordinating committee 4 met January 29, during the 1941 winter convention to discuss general principles for rating of electrical apparatus for intermittent or short-time duty cycles. It is proposed that the committee will ultimately prepare a pamphlet on this subject, supplementary to the AIEE No. 1 pamphlet (General Principles Upon Which Temperature Limits Are Based in the Rating of Electrical Machinery and Apparatus) published last June.

The broad objective of the committee is to establish definitions and principles that will enable the short-time or intermittent duty performances of electrical systems to be adequately described. At the present time, methods in use for rating short-time duty apparatus vary widely in the different fields of cables, transformers, motors, and control. Further, methods of rating commonly used do not distinguish clearly between the thermal and other limitations of output.

The output of some electrical apparatus, such as transformers, is limited primarily by thermal considerations, but in most cases other limitations are equally if not more important. For example, the breakdown torque of an induction motor, the commutating limit of a d-c machine, or the slipping torque of the wheels on a locomotive are definite limits of output, which are quite independent of the thermal limits. It is necessary, therefore, to recognize both of these limits in the application of equipment to duty cycle service. The problem is to include these independent factors in the method of rating in such a way as to permit easy correlation of the different elements of a complete system, and at the same time allow definite and simple performance tests.

The discussion in the committee meeting was continued at the session on rating of electrical machinery and apparatus, January 30, where three papers bearing on this subject were discussed. While no definite conclusions were reached, the consensus was that the service-factor method of rating for welding apparatus, proposed by R. C. Freeman and A. U. Welch, represents a distinct forward step, which may be usefully applied to other systems besides welders. In this system, the name-plate rating of the apparatus represents the expected output under short time or intermittent operating conditions. The permissible continuous output is expressed as a product of the name-plate rating by a service factor less than unity, and the performance tests require a continuous heat run at the service-factor rating.

The committee plans to hold another meeting during the summer convention at Toronto. Meanwhile any Institute members who are interested in this question or have suggestions to make are invited to write to the secretary, E. B. Paxton, Standards Department, General Electric Company, Schenectady, N. Y. (*P. L. Alger, chairman, standards co-ordinating committee 4.*)

MEETING OF COMMITTEE ON DOMESTIC AND COMMERCIAL APPLICATIONS

The recently authorized committee on domestic and commercial applications held its first and organization meeting, January 29. J. O'R. Coleman was designated as secretary of the committee, and the following scope was adopted as tentatively approved at an earlier meeting of the technical program committee:

"Treatment of all matters in which the dominant technical factors are the supply and utilization of electric power in domestic premises, such as single or multiple dwellings, garages and other accessory structures, and in commercial premises such as offices, stores, restaurants, banks, and in institutional buildings such as hospitals, schools, libraries, etc. Such subjects as control, interior wiring, heat-operated and motor-operated appliances or equipment for use in domestic, commercial or institutional premises, including elevators and escalators, are properly within this scope. Subjects relating to the production and application of light as such are within the scope of the committee on production and application of light."

The committee has undertaken to sponsor one full technical session and one conference at the summer convention and plans were discussed for the arrangements to be made for these two occasions, especially for the procurement of papers for the technical session, which will probably be devoted largely to the application problems of motor-driven appliances. (*Alexander Maxwell, chairman.*)

MEETING OF COMMITTEE ON PROTECTIVE DEVICES

A meeting of the committee on protective devices was held January 29, 32 members and 5 guests present. The chairmen of the subcommittees on circuit breakers, switches, and fuses; on relays, on lightning arresters, on fault-current limiting devices, and on insulation co-ordination reported on the activities of their various groups. It developed that the committee on protective devices is now working on or following the revision of nine apparatus standards, some of which are ready for release on a trial period basis.

The subjects of temperature rise and ambient temperature came in for considerable discussion as pertaining to apparatus ratings. In connection with Standards No. 27, Switchgear Assemblies, which is now approved for a one-year trial period, the committee adopted the following resolution:

WHEREAS: AIEE Proposed Standard No. 27—Switchgear Assemblies has been approved for publication as a report by both the Protective

Devices Committee and Standards Committee and

WHEREAS: The interpretation of Paragraph 250 and Paragraph 252 has been found not to be clear,

BE IT RESOLVED: The Protective Devices Committee interpret the rules in AIEE Proposed Standard No. 27—Switchgear Assemblies as if the following footnote were added to Paragraphs 250 and 252:

"For test purposes, a temperature rise of 45°C over the outside ambient will be accepted as meeting the requirements of Rule 27-250 and 27-252."

A working group of the subcommittee on circuit breakers, switches, and fuses presented a memorandum on "Dielectric Strength of Oil for Circuit Breaker Testing". This will be put in final form for presentation as a report by the committee.

The Standard for Neutral Grounding Devices was approved and, with some modifications, will be transmitted to the standards committee with the recommendation that it be published for one-year trial use.

The status of the report "Progress in the Art" was given and mention was made of the "Relay Bibliography" which it is expected will shortly be put out in the form of a special publication.

The committee has a comprehensive list of papers which are already prepared or are in the final stages of preparation for future technical sessions. Two sessions were requested for the summer convention at Toronto in June. (*J. R. North, chairman.*)

MEETING OF RESEARCH COMMITTEE

The research committee, meeting January 31, devoted a very busy session particularly to a consideration of research projects of Engineering Foundation for which the Institute acts as sponsor. Reports were received from the advisory committees directing two of these projects and on the basis of these, recommendations are to be made to the board of directors of the Institute. (*W. F. Davidson, chairman.*)

MEETING OF COMMITTEE ON SAFETY

At the meeting of the committee on safety January 29, emphasis was placed on the importance of continued and increased effort to promote safety. Fires and accidents from electrical causes can cause loss of production due to delays in making repairs, loss of electrical and other material and equipment due to destruction, and injury or loss of life of workers. Safe methods of construction, installation, and operation of electrical equipment are well known, but the committee felt that steps should be taken to urge upon the members of the Institute that greater than usual attention be given to the problems.

As steps in this direction, the committee agreed to urge the Student Branches and the Sections to include in meetings which they may sponsor lectures, papers, and motion pictures on various phases of the safety problem.

Information and suggestions were supplied to all the Student Branches early in the autumn of 1940 which it was hoped would guide them in the development of programs on the subjects. Reports received thus far indicate an aroused interest and a larger number of safety discussions in Student Branches on this subject. It was decided to continue the effort this coming autumn by issuing to the Branches a revised bulletin on the subject.

A letter to all the Sections of the Institute encouraged them to include safety among the subjects which they discuss during the current year. Reports indicate that they too are giving more attention to the matter.

Attention of the national technical committees will be called to the importance of consideration of safety problems in connection with the apparatus and problems that come within the scopes of their activities.

The importance of proper maintenance was stressed by the committee as being essential to continued safety. It was pointed out that with all machinery operated at full capacity, in many cases 24 hours per day, the burden upon the electrical equipment is very heavy and failures are likely to increase in number and severity unless there is proper maintenance. Efforts will be made to bring about a greater appreciation of the importance of this problem on the part of users and operators of electrical equipment.

A survey of recent papers dealing with problems involved in the field of safety indicates that additional information is needed on certain subjects. Among these were accurate information on the body resistances and limits of current endurance of farm animals, information which seems to be needed in order to establish a proper basis for determining the principles of safe installation of electrical equipment in barns and elsewhere on farms. (*Frank Thornton, Jr., chairman.*)

Instruments and Measurements Committee Activities Reported at Convention

At the session on instruments and measurements held at the winter convention on January 31, 1941, T. S. Gray, secretary of the committee presented a detailed report of the committee's scope and accomplishments. Full text of the report follows.

The committee on instruments and measurements, which was organized 24 years ago, has now grown to 35 members with nine subcommittees. The purpose of the committee is to promote and co-ordinate activity in its field. This work includes the review of papers, the arrangement for their presentation at technical sessions, the sponsorship of technical conferences for the discussion of controversial questions, and the preparation of standards, definition, test codes, and reports on the progress of the art in the field of instruments and measurements.

In this report I hope to give you some of the highlights of the work of our committee that goes on behind the scenes. A large part of this work is done by subcommittees. These often include members from other technical committees. Such co-operation is of great importance in the co-ordination of the Institute's activities.

One major work of a subcommittee has been the revision of Standard No. 4 on "The Measurement of Test Voltage in Dielectric Tests." This standard, which was recently completed, describes the methods of measurement of test voltage and of the wave shape of the test voltage used in dielectric tests of electrical apparatus and insulating material. Three classes of tests are included—puncture, flashover, and voltage-proof, using alternating current, direct current, or a surge. The standard includes extensive tables for the spark-over voltages for sphere gaps. It is expected that similar work in other countries eventually may lead to the preparation of a universal standard by the International Electrotechnical Commission.

A second problem in the field of dielectric measurements recently handled by a subcommittee is the preparation of a report on "Wave Form in Dielectric Power-Factor Measurements." This report was published in ELECTRICAL ENGINEERING last year (*EE, June '40, p. 255*). It considers the effect of the wave form used in power-factor measurements on insulating materials and apparatus, and takes up the relative applicability of the terms "form factor", "deviation factor", and "distortion factor" to the specification of the wave form. It recommends that "distortion factor" be used for the specification of the voltage wave form of the power source employed in measurements.

Still a third problem associated with the others on dielectric tests is that of dielectric measurements in the field. A subcommittee is now active on this matter, and a technical conference was held at the last summer convention at Swampscott. Between 50 and 60 Institute members attended, and seven prepared reports were presented.

Dielectric measurements are made in the field to differentiate good insulation from deteriorated insulation, so that the latter may be removed from service before failure occurs and later investigated to determine the possibilities for reconditioning and the cause of the deterioration. More than a million such tests have been made with portable measuring equipment on various types of apparatus. Our subcommittee is engaged in the preparation of a report that will describe the various methods of measurement now in use and give the advantages, disadvantages, and other characteristics of each. It is hoped that this work will result in the formulation of a standard for such measuring equipment in the future.

In another phase of standardization activity, several members of our committee served on a sectional committee of the American Standards Association in the preparation of an American Standard for Electrical Indicating Instruments (No. C-39) published three years ago.

The Institute has a general plan that all of its technical committees shall report periodically on progress in various branches of electrical engineering. In line with that plan, the instruments and measurements committee has been active in the preparation of two such progress reports.

The first of these is a report on "Telemetering and Supervisory Control", which was recently completed by a joint subcommittee of the committees on instruments and measurements and on automatic sta-

Future AIEE Meetings

North Eastern District Meeting
Rochester, N. Y., April 30–May 2, 1941

Summer Convention
Toronto, Canada, June 16–20, 1941

Pacific Coast Convention
Yellowstone National Park, August 27–29, 1941

tions. This report contains a classification of 53 of the numerous types of telemetering and supervisory control equipment now manufactured, a description of each type, and a tabulation of the characteristics of each.

The second progress report is on "Progress in the Art of Metering Electrical Energy", and is now nearing completion. This report differs from others, since no previous progress report has been made on the subject of metering by the Institute. Thus, the scope is much wider, and the development of electrical-energy measurement must be traced from its inception down to the present time. The manuscript is the result of collaboration by authorities in various fields—educational, manufacturing, operating, regulatory, and scientific—although it is necessarily limited in length by the economics of the situation. The manuscript should be completed before the summer convention.

Considerable work is done by our committee in conjunction with, or at suggestion of, other committees. An example is the recent appointment of a subcommittee to prepare a test code on resistance measurement. The writing of test codes for the determination of the performance of electrical apparatus has been one of the most useful standards activities of the Institute during the past few years. It is now expected that our committee will be active in the preparation of several master test codes relating to test methods for measuring certain quantities common to many types of equipment. These measurement test codes are confined to the description of the test methods; the interpretation of the results is left to the test codes on specific types of apparatus. The apparatus test codes will refer to, or incorporate as an integral part, portions of the master code on the methods of measurement.

Other work on test codes has been done recently by a subcommittee working closely with the committee on electrical machinery in the matter of preparing the measurement part of the test codes on transformers, d-c machines, induction machines, and synchronous machines, some of which have already been published.

The formulation of definitions is an important phase of our activity. One subcommittee is reviewing the definitions in a tentative American Standard, and is attempting to correlate these definitions with those in the "Electrical Metermen's Handbook" and the "Code for Electricity Meters."

The differences of opinion and the lively discussion that results when an attempt is made to establish a definition might be surprising to some. An example of the difficulty is the recent criticism of the AIEE definitions of "instrument" and "meter" by a member of the standards committee of another professional society. As you may know, our present definition of "meter" restricts the use of the term to an integrating device such as the watt-hour meter. Ammeters, voltmeters, and wattmeters, which measure the present value of a quantity, are electrical instruments, not meters. A subcommittee has recently been set up to reconsider these definitions and to determine whether or not they should be modified. A great many comments have already been received for consideration by the subcommittee.

Other activities of our committee include a subcommittee to establish suitable methods of stating the performance or accuracy of indicating instruments. The method used at present is to state the accuracy as a percentage of the full-scale indication. This method is not entirely satisfactory because it does not provide for differences in the limiting conditions that exist in the many types of instruments.

Finally, as a means of co-ordination within the Institute, our committee has representatives on the joint subcommittee on electronics, the electrical machinery committee, the standards co-ordinating committee on basic theories and units, and the relay subcommittee of the protective devices committee.

From this brief description I think you can understand, then, that aside from the work of the committee in reviewing papers and in sponsoring sessions at conventions, there is much work done behind the scenes that is of vital importance to the electrical-engineering profession.

Canada Invites AIEE Members to Summer Convention in Toronto

Cordial invitations have been extended by Canadian officials to AIEE members to visit Canada and attend the summer convention to be held in Toronto, June 16–20, 1941. For those who attended the summer convention in Toronto in June 1930 nothing further need be said and for those who will attend this year a treat is in store. Vacation opportunities for the tourist and sportsman abound among the rugged scenery, inland waterways, and lakes of Ontario. The Royal York Hotel, convention headquarters, has excellent accommodations and convention facilities.

BORDER REQUIREMENTS ARE SIMPLE

No difficulties are experienced in crossing the Canadian border even during present world conditions. Passports are not required for permanent residents of the United States entering Canada as tourists. As a matter of convenience they should carry identification. The necessary formalities at the border take but a few minutes. Tourists simply report to the Canadian customs officers at the port of entry, answer the necessary questions, and obtain the requisite permit for admission of car and outfit. It is absolutely unnecessary for a tourist entering Canada to pay any fee for an automobile entry permit or its extension. Personal effects "such as are appropriate for the immediate purpose and convenience of the journey" are admitted duty free. Fifty cigars, 200 cigarettes, and two pounds of tobacco in open packages may be brought in free of duty.

Bona fide American citizens have no difficulty in returning across the border. They may possibly be asked by the United States immigration authorities to show papers to establish identity and place of residence. In such case, any of the following personal documents would be useful: birth or baptismal certificate, voter's certificate, tax bills, letter of identification from a bank manager or responsible municipal official, personal letters, car license, driver's license, registration certificate, business identification cards, etc. It is suggested that naturalized citizens carry with them their naturalization certificates.

A premium exists in Canada on United States dollars, and the Foreign Exchange Control Board has made it obligatory for Canadians accepting United States currency in payment for goods and services to pay the premium, which since the beginning of the war has been about ten per cent.

Exchange problems do not exist. The tourist may exchange his currency as he needs it, as a matter of convenience. It is not suggested that money be changed in large quantities. United States currency can be used conveniently at any time and the full rate of exchange will be paid anywhere.

Tourists returning to the United States after a stay of 48 hours or more may take back articles acquired in Canada but not intended for sale in the United States aggregating up to $100 in value. Foodstuffs, cigarettes, tobacco, 100 cigars, and not over one wine gallon of distilled spirits, wines, or malt liquors (provided the quantity is not prohibited by state law) may be included in this exemption. Each member of a family is entitled to this exemption of $100. When husband and wife, or parents and minor or financially dependent children, are traveling together, such exemption may be grouped and allowance made without regard to which member is the owner.

Further information may be had from D. G. Geiger, secretary, general committee, 1941 summer convention, care of The Bell Telephone Company of Canada, Toronto, or from the Canadian Travel Bureau, Ottawa.

SUMMER CONVENTION COMMITTEE

The personnel of the summer convention committee is as follows:

M. J. McHenry, *chairman;* A. H. Frampton, *vice-chairman;* D. G. Geiger, *secretary;* C. E. McWilliam, *treasurer;* A. W. Bradt, C. H. Burchill, E. V. Caton, R. B. Chandler, K. V. Farmer, W. G. C. Gliddon, H. W. Haberl, G. R. Langley, J. H. Steede, and B. J. O. Strong. *Subcommittee chairmen:* M. J. McHenry, *finance;* T. W. Hill, *publicity;* W. J. Gilson, *entertainment;* T. W. Eadie, *sports;* J. F. Neild, *transportation;* V. G. Smith,

trips; F. F. Ambuhl, *hotel and registration;* O. W. Titus, *women's entertainment;* J. W. Barker, *technical program;* O. W. Titus, *local representative, technical program;* M. S. Coover, *Sections;* and J. M. Thomson, *local representative, Sections.*

In Memoriam

THE death of Doctor Lewis Buckley Stillwell, on January 19, 1941, removed from the membership of the Institute its 22d president and a leading pioneer in electric power development who had been rated among the nation's leading electrical engineers during half a century.

After his graduation from Lehigh University in 1885, he became assistant electrician of the Westinghouse Electric and Manufacturing Company. He was chief electrical engineer, 1890–97, and also assistant manager of the company from 1895 to 1897. He directed the layout and design of the first plant of the Niagara Falls Power Company and the Cataract Construction Company at Niagara Falls. In 1897, he became electrical director of the Niagara Falls Power Company. He began his practice as a consulting engineer in New York City in 1900 and filled engagements with many companies on large engineering projects, including the Interborough Rapid Transit Company subway system, the Hudson and Manhattan tubes, and the Holland Tunnel.

LEWIS BUCKLEY STILLWELL

Doctor Stillwell made several notable inventions, and was an outstanding leader in the generation, transmission, and distribution of electric power.

He received many honors, including the honorary degree of Doctor of Science from Wesleyan University in 1907, and from Lehigh University in 1914, the AIEE Lamme Medal for 1933, the Edison Medal for 1935, and other medals.

He joined the Institute in 1892, and was transferred to the grade of Member in the same year. He was transferred to the grade of Fellow in 1912. He served on many of the most important Institute committees, and was the author of technical papers of outstanding importance. He was a director, 1896–99, vice-president, 1899–1901, and president, 1909–10.

RESOLVED: That, upon behalf of the membership, the board of directors of the American Institute of Electrical Engineers hereby expresses its appreciation of Doctor Stillwell's many contributions to the development of Institute activities and its keen regret at his death, and be it further

RESOLVED: That these resolutions be entered in the minutes and transmitted to the members of Doctor Stillwell's family.

—AIEE Board of Directors, January 30, 1941

Board of Directors Meets During Winter Convention

The regular meeting of the AIEE board of directors was held at the Bellevue-Stratford Hotel, Philadelphia, Pa., on January 30, 1941, during the annual winter convention of the Institute.

Reporting on a subject that had been referred to it by the board of directors, namely, the possibility of a method of transfer to Fellow grade by invitation and recommendations thereon made by the conference of officers, delegates, and members in June 1940, the board of examiners recommended two procedures for transfer to the grade of Fellow: the present procedure, under which transfers are proposed by five Fellows or Members and the application is prepared and signed by the candidate; and an invitational procedure, providing for a preliminary consideration and action by the board of examiners upon submission of the proposal form and an application form, signed by the sponsor, containing a complete statement of the candidate's professional record and experience and the names of the required references. Upon favorable action by the board of examiners, the application form would be submitted to the candidate for his signature, after which it would pass through the present routine procedure for effecting the transfer, that is, recommendation by the board of examiners, posting in ELECTRICAL ENGINEERING, and final action by the board of directors. The board of directors approved the recommendation of the board of examiners providing two procedures for transfer to the grade of Fellow.

Upon recommendation of the chairmen of the publication and technical program committees, the publication committee was authorized to publish as special publications of the Institute, on a self-supporting basis, similar to the Lightning Reference Book previously issued by the Institute, two technical committee reports, one on the subject of telemetering, and the other on relays. The charge for these publications will be determined by a committee consisting of the chairmen of the finance, publication, and technical program committees.

Recommendations of the headquarters committee for renovation of certain rooms at Institute headquarters (foyer, hall, alcove, members' lounge, and board room), were presented and approved, the cost to be met from the property fund for equipment replacements.

Upon petition in the prescribed form and recommendation of the Sections committee, two new Sections of the Institute were authorized, South Bend Section and Arizona Section. (See page 138.) Upon request of the members of the Section and approval by the Sections committee, the board authorized a change in name of the El Paso Section to "New Mexico-West Texas Section".

Upon petition and recommendation of the committee on Student Branches, the board authorized the organization of two new Student Branches of the Institute, namely, Manhattan College Branch, in New York City, and The University of Connecticut Branch, in Storrs, Conn.

Several amendments to the Institute bylaws were adopted. To extend the period of time in which Enrolled Students may apply for admission to the Associate grade without payment of the entrance fee, Sections 53 and 57 were amended to read:

"Sec. 53. The annual Student enrollment fee shall be three dollars ($3.00) payable in advance and shall cover the fiscal year of the Institute beginning on May first. The initial payment upon application for enrollment shall be on the basis of a full year's fee, three dollars ($3.00), or a half year's fee, one dollar and fifty cents ($1.50), depending upon whether the application is filed nearer to May first or November first, respectively. The term of Student enrollment shall not extend beyond the end of the fiscal year (April 30) in which student status ceases, except in those cases where the fiscal year ends within six months after graduation; in those cases Student enrollment may be continued for one additional year. For those students who are not devoting their entire time or a major part of their time to studies, the term of enrollment shall not extend over a period of more than five consecutive years.

Sec. 57. A student must apply for admission to the Associate grade before the first of March of the fiscal year in which his Student enrollment ceases in order to be relieved of the payment of the entrance fee as provided for in the Constitution.

The following new sections were adopted to cover the Charles LeGeyt Fortescue Fellowship committee and the committee on research, recently changed from a technical committee to a general committee:

Sec. 79A. The Charles LeGeyt Fortescue Fellowship committee shall consist of six members appointed by the president, with the appointments confirmed by the board of directors. The committee shall award each year to a student of electrical engineering, who shall have received a baccalaureate degree from a duly recognized technical school in the United States or Canada, a fellowship for postgraduate work in some special field of electrical engineering, in accordance with the regulations prescribed in the bylaws of the committee as approved by the board of directors.

Sec. 84A. The committee on research shall stimulate research of interest to the Institute; shall act on behalf of the Institute, as authorized specifically by the board of directors, to initiate and direct research investigations; shall co-operate, on behalf of the Institute, with departments of national and state governments in the consideration of research investigations; shall submit to the board of directors reports and recommendations concerning research investigations for which financial support from the Institute is sought; shall assist university staffs in selecting research projects for graduate students; and shall assist the technical program committee, as requested, in the preparation of meetings for the discussion of problems in the field of research.

Sec. 65 was amended by the addition of certain general committees not hitherto included and new technical committees, and by the deletion of discontinued committees.

Upon recommendation of the committee on planning and co-ordination, to which had been referred the suggestion for such committee, the board authorized the establishment of a new technical committee of the Institute, to be known as the committee on applications of electricity to therapeutics, to include within its scope all applications of electricity having to do with health, such as sanitation, sterilization, radiation, etc., the exact definition of its scope to be developed by the committee and the technical program committee.

The board voted to appoint an AIEE special committee on national defense.

A recommendation of the committee on air transportation that "the Institute place its facilities at the disposal of the Army-Navy Aeronautical Board, to assist in the development and co-ordination of aeronautical electrical equipment," was presented, and the board approved the recommendation in principle, and instructed the committee to co-operate with the government bureaus.

Approval was given to a recommendation of the chairman of the committee on power generation for the appointment of a joint committee of The American Society of Mechanical Engineers and the AIEE to formulate specifications for prime-mover speed-control devices.

In view of the fact that American Engineering Council terminated its activities on December 31, 1940, Doctor Dugald C. Jackson (chairman) was authorized to continue to act with the other members of the former AEC committee studying the subject of a joint code of ethics for the engineering profession, as a joint committee of the societies concerned to complete the work.

Representatives of the Institute were appointed, as follows:

H. H. Barnes, Jr., reappointed a member of the Hoover Medal board of award for the six-year term beginning in May 1941.

G. L. Knight was appointed to the board of trustees, United Engineering Trustees, Inc., for the four-year term beginning in October 1940.

H. S. Osborne was appointed an additional alternate of the Institute on the Standards Council of the American Standards Association for the year 1941. Appointment of two representatives on the Council of the American Association for the Advancement of Science for the year 1941 was referred to the president with power.

John C. Parker was designated to be recommended for appointment as the Institute's representative on the committee appointed by the Secretary of War to study the protection of civilians in time of war.

C. R. Beardsley was appointed, upon request of the National Council of State Boards of Engineering Examiners, as a representative from the New York Section to serve on the general committee in charge of the 1941 meeting of the NCSBEE, to be held in New York City, October 27–30.

Approval was given to revisions of the rules for the award of AIEE District prizes which were recommended by the chairman of the committee on award of Institute prizes. These revisions provided that previous presentation of an undergraduate student paper shall not bar the subsequent award of an initial paper prize, and changed the closing date for the receipt of papers for District prize awards from February 15 to February 1.

The board, by rising vote, adopted a resolution in memory of Past President Lewis B. Stillwell, who died on January 19, 1941. (See page 135.)

The board directed that an expression of its sincere appreciation of the excellent arrangements made for the 1941 winter convention, in Philadelphia, and the gratifying success attained, be transmitted to the winter convention committee.

Actions relating to Institute meetings were taken, as follows:

A resolution was adopted to the effect that the 1941 annual meeting of the Institute will be held in Toronto, Ontario, on Tuesday, June 17. Dates were approved for the previously authorized South West District meeting in St. Louis—October 8–10, 1941; and for the previously authorized Southern District meeting in New Orleans—December 3–5, 1941. The Great Lakes District meeting, which was to have been held in Fort Wayne, Ind., in April 1941, was postponed indefinitely, upon recommendation of the District executive committee.

The following schedule of national conventions and District meetings for 1942, as prepared and submitted by the committee on planning and co-ordination, was adopted:

Winter convention, New York, N. Y., January 26–30

Summer convention, Chicago, Ill., June 22–26

North Eastern District meeting, Schenectady, N. Y., early in May

Middle Eastern District meeting, Pittsburgh, Pa., in the fall

Other actions taken by the board included the following:

Minutes of the meeting of the board of directors held on October 25, 1940, were approved.

Actions of the executive committee on applications for transfer, election, and Student enrollment were reported and confirmed, as follows: As of November 19, 1940—8 applicants transferred to grade of Fellow, 10 applicants transferred and 10 elected to the grade of Member, 47 applicants elected to the grade of Associate, 561 Students enrolled. As of December 23, 1940—4 applicants transferred to the grade of Fellow, 13 applicants transferred and 8 elected to the grade of Member; 68 applicants elected to the grade of Associate; 458 Students enrolled.

Reports were presented and approved of meetings of the board of examiners held November 14 and December 19, 1940, and January 23, 1941. Upon recommendation of the board of examiners, the following actions were taken: 1 applicant was transferred to the grade of Fellow; 16 applicants were transferred and 15 were elected to the grade of Member; 74 applicants were elected to the grade of Associate; 130 Students were enrolled.

Monthly expenditures were reported by the finance committee and approved by the board, as follows: \$24,827.28 for November 1940, \$24,194.64 for December 1940, and \$22,293.89 for January 1941.

Those present were:

President—R. W. Sorensen, Pasadena, Calif.

Past President—F. Malcolm Farmer, New York, N. Y.

Vice-Presidents—J. W. Barker, New York, N. Y.; K. L. Hansen, Milwaukee, Wis.; H. W. Hitchcock, Los Angeles, Calif.; C. T. Sinclair, Pittsburgh, Pa.; A. LeRoy Taylor, Salt Lake City, Utah; J. M. Thomson, Toronto, Ont.; A. L. Turner, Omaha, Nebr.

Directors—T. F. Barton, C. R. Beardsley, New York, N. Y.; M. S. Coover, Ames, Iowa; Mark Eldredge, Washington, D. C.; R. E. Hellmund, East Pittsburgh, Pa.; F. H. Lane, Chicago, Ill.; F. J. Meyer, Oklahoma City, Okla.; D. C. Prince, Schenectady, N. Y.; R. G. Warner, New Haven, Conn.

National Treasurer—W. I. Slichter, New York, N. Y.

National Secretary—H. H. Henline, New York, N. Y.

Membership—

Mr. Institute Member:

Thank you for your co-operation. The response of members to our appeal was gratifying indeed. Your help, together with the hard work of Section membership committees in interviewing persons suggested by you as eligible for membership, has produced results.

New applications received, six months ending January 31, 1941	618
New applications received, six months ending January 31, 1940	601

Those of you who did not send in the names of eligible prospects for membership among your acquaintances can make up for it by doing so now. Telephone or mail them direct to the chairman of your Section membership committee. His name and address are given on page 33 of the January issue of ELECTRICAL ENGINEERING.

O. C. Brill

Chairman, National Membership Committee

Nominating Committee Announces Official Candidates for 1941

A complete official ticket of candidates for the Institute offices that will become vacant August 1, 1941, was selected by the national nominating committee at its meeting held in Philadelphia, Pa., January 27, 1941. This committee, in accordance with the constitution and bylaws, consists of 15 members, one selected by the executive committee of each of the 10 geographical Districts, and 5 selected by the board of directors from its own membership. The following members were present:

A. S. Anderson, Denver, Colo.; T. F. Barton (alternate), New York, N. Y.; C. R. Beardsley, New York, N. Y.; M. S. Coover, Ames, Iowa; W. E. Crawford (alternate), Milwaukee, Wis.; C. L. Dawes, Cambridge, Mass.; J. F. Fairman, New York, N. Y.; A. H. Frampton, Toronto, Ont.; F. E. Johnson, Jr., New Orleans, La.; L. R. Mapes, Chicago, Ill.; C. W. Mier, Dallas, Tex.; R. F. Monges (alternate), Berkeley, Calif.; W. B. Morton, Philadelphia, Pa.; H. E. Murdock, Bozeman, Mont.; D. C. Prince (alternate—for a part of the meeting), Schenectady, N. Y.; and H. H. Henline, secretary of the committee.

Following is the list of official candidates selected by the committee:

For President

David C. Prince, manager, commercial engineering department, General Electric Company, Schenectady, N. Y.

For Vice-Presidents

N. S. Hibshman, associate professor of electrical engineering, Lehigh University, Bethlehem, Pa. (Middle Eastern District, number 2)

J. Elmer Housley, superintendent of power, Alumi-

num Company of America, Alcoa, Tenn. (Southern District, number 4)

Arthur L. Jones, commercial vice-president and district manager, General Electric Company, Denver, Colo. (North Central District, number 6)

Walter C. Smith, engineer of Pacific district, General Electric Company, San Francisco, Calif. (Pacific District, number 8)

C. A. Price, chief engineer, Canadian Westinghouse Company, Ltd., Hamilton, Ontario, Canada. (Canada District, number 10)

For Directors

Lester R. Gamble, electrical engineer, Washington Water Power Company, Spokane, Wash.

T. G. LeClair, supervising development engineer, Commonwealth Edison Company, Chicago, Ill.

Fred R. Maxwell, Jr., professor of electrical engineering, University of Alabama, University, Ala.

For National Treasurer

W. I. Slichter, professor and head of Department of Electrical Engineering, Columbia University, New York, N. Y.

The constitution and bylaws of the Institute provide that the nominations made by the national nominating committee shall be published in the March issue of Electrical Engineering. Provision is made for independent nominations as indicated in the following excerpts from the constitution and bylaws:

Constitution

Sec. 31. Independent nominations may be made by a petition of twenty-five (25) or more members sent to the national secretary when and as provided in the bylaws; such petitions for the nomination of vice-presidents shall be signed only by members within the District concerned.

Bylaws

Sec. 23. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with Article VI, Section 31 (Constitution), must be received by the secretary of the national nominating committee not later than March 25 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the national nominating committee in accordance with Article VI of the Constitution and sent by the national secretary to all qualified voters during the first week in April of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

(*Signed*) National Nominating Committee
by H. H. Henline, *Secretary*

BIOGRAPHICAL SKETCHES OF NOMINEES

In order that those not personally acquainted with the nominees may know something of them and their qualifications for the Institute offices for which they have been nominated, brief biographical sketches are given in the "Personals" columns of this issue.

AIEE Broadcast Series Ends

The final broadcast of the series currently sponsored by the AIEE on the role of electrical engineers in national defense (*EE, Jan. '41, p. 86*) is being presented March 4, 1941, from 10:15 to 10:30 p.m., with Doctor F. B. Jewett, vice-president, American Telephone and Telegraph Company, and Doctor Karl T. Compton, president, Massachusetts Institute of Technology, discussing electrical research in relation to defense. Presented on the Blue Network stations of the National Broadcasting Company, the series was arranged by the company's educational division.

Four broadcasts during February continued the series, which began with a program from Philadelphia, January 27, in connection with the AIEE winter convention, on the enlistment of the electrical-engineering profession for defense. In addition to well-known engineers, an anonymous "Mr. Jones"—"one of the 130,000,000 who are being defended"—took part in each of the programs.

The second broadcast, on February 3, dealt with the work of electrical engineers in the Army, in an interview with General J. O. Mauborgne, chief signal officer, United States Army. Monday, February 10, Commander E. W. Mills, Bureau of Ships, United States Navy Department, told how the resources of electrical engineers are utilized in the Navy. Assisting in the discussion was Joseph W. Barker, dean of engineering, Columbia University. Activities of electrical engineers in the defense industries were described by Marvin W. Smith, vice-president of the Westinghouse Electric and Manufacturing Company, and R. C. Muir, vice-president of the General Electric Company, on Tuesday, February 18. The broadcast of Tuesday, February 25, covered the mobilization of the nation's electric power facilities for defense. C. W. Kellogg, president of the Edison Electric Institute, and a member of the Advisory Committee to the Council of National Defense, and Dean Edward L. Moreland, Massachusetts Institute of Technology, led the discussion.

COMMENTS WANTED

As this broadcasting venture is of the nature of an experiment for AIEE, the committee in charge would like especially to receive comments and suggestions from interested members concerning the effectiveness of the series just closing, or possibilities for further programs in the future. Address such comments to the national secretary, AIEE headquarters, 33 West 39th Street, New York, N. Y.

District • • • •

North Eastern District Meeting to Be Held at Rochester, N. Y.

A three-day meeting of the North Eastern District will be held in Rochester, N. Y., April 30–May 2, 1941, with headquarters in the Sagamore Hotel.

The program tentatively arranged consists of four technical sessions, two student, and one general session, with a stag party on Wednesday evening, and a banquet on Thursday evening. The papers to be presented in the four technical sessions deal with work in the fields of communication, central stations, technical photography, measurements, dielectrics, electrical machinery, and industrial power applications. Addresses by well-known speakers on timely subjects of interest to many members will be arranged for the general session and the banquet will be addressed by Doctor Alan Valentine, president of the University of Rochester, and R. W. Sorensen, President, AIEE.

An interesting program of events for women guests will be provided and all members are especially urged to bring their wives to the meeting.

District 7 Executive Committee Meets at Dallas

The executive committee of the AIEE South West District met at Dallas, Tex., November 29, 1940, with an attendance of the following Section and other representatives:

J. L. Hamilton, AIEE vice-president, District 7
L. L. Crump, secretary, District 7
J. S. Johnson, chairman, committee on student activities
L. O. Campbell, national membership committee
F. A. Decker, El Paso Section
I. W. Best, El Paso Section
L. H. Mathes, Houston Section
P. H. Underwood, Houston Section
R. R. Miner, Wichita Section (representing P. S. Colby and R. B. Gow)
P. C. Ellis, Kansas City Section
G. K. Shirling, Kansas City Section
J. S. Malsbary, St. Louis Section
J. W. Shawver, Oklahoma City Section
W. B. Stephenson, Oklahoma City Section
H. P. Dougherty, Tulsa Section
W. F. Pinckert, San Antonio Section
Eugene Dissett, San Antonio Section
Gibbs Deyer, North Texas Section (representing H. R. Pearson)
G. H. Pingree, North Texas Section

Action taken by the committee included the election of C. W. Mier, Dallas, Tex., to serve on the national nominating committee, and approval of the appointment of F. A. Decker, H. R. Pearson, R. B. Gow, and W. B. Stephenson to the District coordinating committee.

The problems created by conscription in regard to the transfer of Enrolled Students to Associate membership in the Institute and the payment of Institute dues during military service were discussed by the committee at the suggestion of Chairman J. S. Johnson of the District committee on student activities. The committee voted that the Institute board of directors be requested to consider these problems and take action. This request was submitted to the board in a letter embodying the committee's belief that special provision during the draft period should be made for Students and probably for regular Institute members as well.

Report of activities were presented for all the Sections in District 7, and a general discussion followed. A student meeting is planned for the spring of 1941, to be held at one of the colleges, Chairman Johnson announced. He suggested that a committee be appointed to arrange for student attendance at the District meeting to be held at St. Louis, October 8–10. Plans for the District meeting and national affairs of interest to the District were discussed by Vice-President J. L. Hamilton.

Great Lakes District Meeting Postponed

Indefinite postponement of the Great Lakes District meeting heretofore scheduled to be held in Fort Wayne, Ind., April 23–25, was authorized by the AIEE board of directors at its winter-convention meeting January 30 in Philadelphia. This action was taken upon recommendation of the District committee in charge of the meeting and of the District executive committee. The action reflects the increasing industrial pressure incidental to the national defense program.

Branch • • • •

New Branches Authorized

Organization of two new Student Branches of the Institute was authorized at the meeting of the board of directors January 30, 1941, upon petition and recommendation of the committee on Student Branches. The new Branches are Manhattan College Branch, New York, N. Y., and the University of Connecticut Branch, Storrs, Conn. The total number of AIEE Student Branches is now 124.

Section • • • •

Pittsburgh Section Holds Student Branch Conference

Record attendance of 292, of which 95 were students, is reported for the joint midwinter meeting and Student Branch conference held January 14, 1941, at Pittsburgh, Pa., by the AIEE Pittsburgh Section and the Electrical Section of the Engineers Society of Western Pennsylvania. The program included a student technical session, an inspection trip to the Copperweld Steel Company plant at Glassport, Pa., and a dinner meeting at which President Royal W. Sorensen was guest of honor. Other speakers at the dinner, at which Chairman G. R. Patterson of the Pittsburgh Section presided, were National Secretary H. H. Henline, District 2 Vice-President C. T. Sinclair, Doctor Charles S. Tippetts, dean of school of business administration, University of Pittsburgh, and M. S. Trimble, chairman, Carnegie Institute of Technology Branch, who reported on the Branch conference. The following papers were presented at the technical session, at which Otto Kebernik, chairman, University of Pittsburgh Branch, presided:

VOLTAGE REGULATOR TUBES, **J. M. Pomfrett**, Pennsylvania State College

DESIGN OF ELECTRONIC MUSICAL INSTRUMENTS, **Jobe Jenkins**, Carnegie Institute of Technology

THE ENGINEER'S NEED FOR CULTURAL DEVELOPMENT, **E. S. Reeser**, West Virginia University

THE ELECTRON MICROSCOPE, **W. P. Smith**, University of Pittsburgh

Arizona and South Bend Sections Being Formed

In response to local petitions and in furtherance of the Institute's general policy of placing all parts of the United States within the territory of some Section, two new Sections received the authorization of the AIEE board of directors at its meeting January 30, 1941, and are in process of organization. These are the Arizona Section and the South Bend Section. The territory of the former includes the entire state of Arizona. The South Bend Section includes LaPorte and Porter Counties, Indiana, formerly in the territory of the Chicago Section; and Elkhart and St. Joseph Counties, Indiana, and Berrien County, Michigan, formerly in the territory of the Fort Wayne Section.

These new Sections bring the Institute's total to 72 Sections. Only some 90-odd members in the United States now will be located outside the territory of some Section.

The board also authorized changing the name of the El Paso Section to "New Mexico-West Texas Section", as requested by members of the Section.

Standards • • •

Standards on Conduction in Vacuum, Gases, Liquids, and Solids

A new AIEE standards co-ordinating committee (number 7) on conduction in vacuum, gases, liquids, and solids has been appointed, with R. E. Hellmund as chairman. Because of the very broad scope of the work of this committee, it has been considered advisable to follow the practice which has been found advantageous in the organization of some of the other co-ordinating committees; namely, to appoint a steering committee, the function of which is to appoint subcommittees of specialists for handling specific projects and to guide these subcommittees in their work. Various projects will be taken up from time to time in this manner, as the need for them arises, or as it becomes evident that worthwhile service can be rendered to the profession by such activities.

(For other matters relating to standards, see pages 132 and 147.)

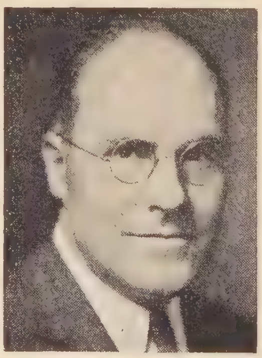
Personal • • •

D. C. Prince Nominated for Institute President

David Chandler Prince (A'16, F'26) manager of the commercial engineering department, General Electric Company, Schenectady, N. Y., has been nominated for the presidency of the AIEE for the 1941–42 term. He was born February 5, 1891, at Springfield, Ill., and received the degrees of bachelor of science in electrical engineering, 1912, and master of science in electrical engineering, 1913, from the University of Illinois. Following graduation he spent a year with General Electric at Schenectady, in the test course and on special problems. From 1914 to 1917 he was employed on valuations and rate-making by the Illinois State Public Utilities Commission and from 1917 to 1919 was a first lieutenant in the ordnance department of the United States Army, where he was attached to Air Service headquarters in Paris, France. He returned to General Electric in 1919 and during the following year served as a special representative in Poland. He was appointed a research engineer in the radio department in 1920, and in 1923 was assigned to the research laboratory, first on vacuum-tube applications and later as head of the power control section. He was transferred to Philadelphia in 1929 as research engineer of the switchgear department. He was chief engineer of the Philadelphia plant from 1931 to 1940, when he was given his present appointment. He is the author of many technical papers and articles, is co-author of two books, and holder of 76 patents. He was honored in 1940 as a "modern pioneer" by the National Association of Manufacturers. He is at present a director of the Institute and a member of the Edison Medal, Fortescue Fellowship, transfers, protective devices, and air transportation committees, and has also been a member of the board of examiners (1938–40), finance committee (1938–40), and Lamme Medal committee (1936–39). He is a past chairman of the Philadelphia Section.

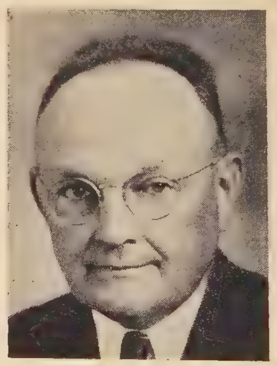
Vice-Presidential Nominees Are Hibshman, Housley, Jones, Smith, and Price

Nelson Sherk Hibshman (A'27, M'32) associate professor of electrical engineering, Lehigh University, Bethlehem, Pa., has been nominated for vice-president of the AIEE Middle Eastern District (2). He was born at Harrisburg, Pa., January 20, 1902, and received the degree of bachelor of science in electrical engineering from Pennsylvania State College in 1924, and that of master of science from Lehigh University in 1927. He entered the department of electrical engineering at Lehigh in 1927 with the rank of assistant professor, later becoming associate professor. He has also been employed at various times in the steel,



D. C. PRINCE

N. S. HIBSHMAN



J. E. HOUSLEY

automotive, telephone, and electrical manufacturing industries, and has published researches in rectification machinery and electric arc welding. He is at present serving on the staff of the regional adviser for engineering defense training. He has served the Institute as chairman of the Lehigh Valley Section, counselor of the Lehigh Student Branch, and a member of the committee on instruments and measurements. He is a member of Eta Kappa Nu, Tau Beta Pi, and Sigma Xi.

John Elmer Housley (A'19, M'39) superintendent of power, Aluminum Company of America, Alcoa, Tenn., has been nominated for vice-president of the AIEE Southern District (4). He was born at Knoxville, Tenn., January 9, 1893, and received the degree of bachelor of science in electrical engineering from the University of Tennessee in 1915. The same year he was employed by the Aluminum Ore Company, East St. Louis, Ill., as engineer apprentice, becoming electric shop foreman in 1916, electrical engineer in 1917, and assistant superintendent of power in 1921. In 1922 he became a sales engineer for the Aluminum Company of America, with headquarters at Kansas City, Mo., and the following year returned to the Aluminum Ore Company on special engineering work. In 1924 he became assistant district electrical superintendent of the Tallahassee Power Company, Alcoa, and in 1927 superintendent of power of the Aluminum Company of America. He is a member of the Institute's committee on electrochemistry and electrometallurgy, vice-chairman of District 4, and a past chairman of the East Tennessee Section. He has written a number of technical articles.

Arthur Lucas Jones (A'07, M'26, F'38) commercial vice-president and district manager, General Electric Company, Denver, Colo., has been nominated for vice-president of the AIEE North Central District (6). He was born May 22, 1879, at Ballston, N. Y., and received the degree of mechanical engineer from Cornell University in 1904. He entered the test department of the General Electric Company at Schenectady, N. Y., in 1904, and in 1907 was transferred to the power and mining engineering department. In 1909 he was sent to the Denver office as district engineer of the Rocky Mountain district. He was appointed assistant district manager in 1926, district manager in 1928, and in 1936 was appointed commercial vice-president, continuing the duties of district manager. He is a past chairman of the Denver Section.

Walter Charles Smith (A'07, M'26, F'40) district engineer, Pacific district, General Electric Company, San Francisco, Calif., has been nominated for vice-president of the AIEE Pacific District (8). Born January 9, 1882, at Clarkston, Mich., he received the degree of bachelor of science in electrical engineering at the University of Michigan in 1905. Shortly after graduation he entered the test department of the General Electric Company at Schenectady, N. Y., and in 1907 was transferred to the transformer engineering department. The following year he was transferred to Pittsfield, Mass., continuing there until 1918, in the transformer and distribution transformer engineering departments. He was engaged in special investigation work for the transformer department, with headquarters at the company's Denver, Colo., office, from 1918 to 1920, when he became sales engineer at the San Francisco office. He was made assistant engineer of the latter office in 1931 and in 1932 became chief engineer, a position he held until his appointment as district engineer at the beginning of 1941. He received a Coffin Award in 1925 for "ingenious design of combined transformer and autotransformer". He is a past chairman of the Pittsfield Section and of the San Francisco Section, and is a member of the committee on principles of professional conduct.

Clarence Albert Price (A'19, M'39) chief engineer, Canadian Westinghouse Company, Ltd., Hamilton, Ont., Canada, has been nominated for vice-president of the AIEE Canada District (10). He was born at Crumlyne, Pa., October 13, 1875, and studied mechanical arts and electrical engineering at Drexel Institute, graduating in 1898. He spent some months in general work on electrical apparatus before becoming laboratory assistant in the insulated wire department of John A. Roebling Sons Company, Trenton, N. J., in 1900. In 1901 he was employed by the Bell Telephone Company of Philadelphia, Pa., and in 1902 became an engineering apprentice with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. He was engaged on induction motor design at East Pittsburgh from 1904 until 1906, when he was transferred to Canadian Westinghouse in the same capacity. He became assistant chief engineer of that company in 1919 and has been chief engineer since 1936. He is a past chairman of the Toronto Section.

A. L. JONES

W. C. SMITH

C. A. PRICE

Gamble, Le Clair, and Maxwell Nominated for Institute Directorships

Lester Raymond Gamble (A'23, M'28, F'39) engineer in charge of the electrical department, Washington Water Power Company, Spokane, Wash., has been nominated for membership on the AIEE board of directors. Born at Carter, Wyo., November 24, 1888, he received the degree of bachelor of science in electrical engineering from Purdue University in 1914. Following graduation he was employed as a lineman by the Utah Light and Traction Company (later Utah Power and Light Company), Ogden, and in 1915 was transferred to Salt Lake City as a draftsman. He was appointed assistant distribution engineer in 1916. He was a captain in the Engineer Corps of the United States Army 1917–19, during which time he supervised the construction of buildings, transmission lines, and distribution systems in France. In 1919 he returned to his former position with the Utah Power and Light Company where he continued until 1923. He then became engineer in the distribution department of the Washington Water Power Company, and in 1925 was made assistant electrical engineer. Since 1933 he has been electrical engineer in charge of the company's electrical department and construction budget. During 1925–26 he directed an electric-range survey for the National Electric Light Association and made a report of the findings. He was vice-president of the North West District 1938–40, is a member of the standards committee and was a member of the committee on production and application of light (1938–40), and is a past chairman of the Spokane Section.

Titus George Le Clair (A'24, M'29, F'40) supervising development engineer, Commonwealth Edison Company, Chicago, Ill., has been nominated for membership on the AIEE board of directors. He was born at Superior, Wis., August 26, 1899, and received the degree of bachelor of science in electrical engineering from the University of Idaho in 1921. He spent a year and a half as student engineer with General Electric Company, Schenectady, N. Y., before entering the employ of Commonwealth Edison Company in 1923 as a cable engineer. He was transferred to the inside plant department as substation field engineer the following year and in 1927 became engineer of system protection. In 1930 he became a staff engineer in the office of the chief electrical engineer, in 1932 was made development engineer, and since 1936 has been supervising development engineer. He holds patents on several inventions and is the author of technical papers and articles. He is a member and trustee of the Western Society of Engineers. He is a member of the AIEE committees on professional development and on legislation affecting the engineering profession, and was a member of the membership commit-

tee (1930–35). He is a past chairman of the Chicago Section.

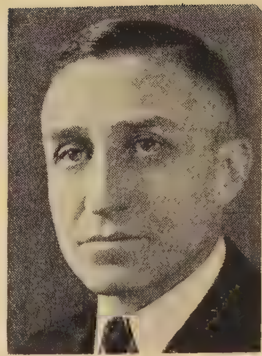
Frederick Richard Maxwell, Jr. (M'30) professor of electrical engineering, University of Alabama, Tuscaloosa, has been nominated for membership on the AIEE board of directors. He was born at Tuscaloosa, June 15, 1889, and received the degrees of bachelor of science, 1911, mechanical engineer, 1912, and electrical engineer, 1923, from the University of Alabama. In 1913 he was employed on plant operation by the Tuscaloosa Ice and Light Company, later the Tuscaloosa Railway and Utilities Company, and in 1916 was made commercial manager. After two years (1917–19) in the United States Naval Reserve, he returned to the company as assistant general manager. In 1920 he became instructor in electrical engineering and physics at the University of Alabama, becoming assistant professor the following year, associate professor in 1923, and full professor in 1934. He is at present vice-president of the AIEE Southern District, and a member of the committee on electrochemistry and electrometallurgy, and has been chairman of the Alabama Section, vice-chairman of the District, and counselor of the University of Alabama Student Branch. He is a member of the Society for the Promotion of Engineering Education and of Tau Beta Pi.

W. I. Slichter Renominated as Institute Treasurer

Walter Irvine Slichter (A'00, M'03, F'12) professor and head of the department of electrical engineering, Columbia University, New York, N. Y., has been renominated to serve as treasurer of the AIEE. He has held the position of national treasurer since 1930, and has also served as a manager (1918–22), vice-president (1922–24), and member of many standing and special committees. He is at present a member of the executive, Edison Medal, Fortescue Fellowship, Columbia University scholarships, constitution and bylaws, and land transportation committees; represents the Institute on the boards of the Engineering Societies Library and the Engineering Foundation, the advisory board of the National Bureau of Engineering Registration, and the Engineering Societies Monographs committee; and is chairman of the special committee on pension plans. A biographical sketch of Professor Slichter appeared in the March 1937 issue, page 136.

C. A. Adams to Receive Lamme Medal for 1940

Comfort Avery Adams (A'94, M'05, F'13) consulting engineer, Edward G. Budd Manufacturing Company, Philadelphia, Pa., has been awarded the AIEE Lamme Medal for 1940 "for his contributions to the theory and design of a-c machinery and his work in the field of electric welding." He was born at Cleveland, Ohio, November 1, 1868, and received the degree of bachelor of science in 1890 from the Case School of Applied Science and that of electrical engineer in 1905 from Harvard University. He also received the honorary degree of doctor of engineering from Harvard in 1925, and from Lehigh University in 1939. During the summer of 1890 he went with the Reid Expedition to Alaska making magnetic and meteorological observations and for the following year was a draftsman for the Brush Electric Company, Cleveland. He became an instructor in electrical engineering at Harvard University in 1891 and continued as a member of the Harvard faculty, as assistant professor, 1896–1906, professor, 1906–16, Lawrence professor of engineering, 1914–36, dean of the engineering school, 1919–21, until his retirement from teaching in 1936, when he was made professor emeritus. In addition to teaching, he carried on an extensive consulting practice on which he has concentrated since 1936. In addition to the Budd company, his connections include the Babcock and Wilcox Company, Okonite Company, and others. He has served the Institute as a manager (1912–15), vice-president (1915–17), and president (1918–19), and as member or chairman of many committees, and has represented the Institute on various bodies. He is at present a member of the standards committee, and chairman of the welding research committee of the Engineering Foundation. He was one of the organizers and first chairman of The American Engineering Standards Committee, from which the American Standards Association grew. He was the first president of the American Welding Society, and is also a member of the American Academy of Arts and Sciences, American Association for the Advancement of Science, American Physical Society, Society for the Promotion of Engineering Education, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society of Testing Materials, and of several foreign technical societies.



L. R. GAMBLE

T. G. LE CLAIR

F. R. MAXWELL, JR.

C. A. ADAMS

Obituary • • •

Lewis Buckley Stillwell (A'92, M'92, F'12, past president) consulting engineer, Princeton, N. J., died January 19, 1941, at Baltimore, Md. He was born March 12, 1863, at Scranton, Pa., studied at Wesleyan University 1892–94, and received the degree of electrical engineer, 1885, from Lehigh University, and the honorary degrees of master of science, 1907, and doctor of science, 1914, from Lehigh University, and that of doctor of science, 1907, from Wesleyan University. He entered the employ of the Westinghouse Electric and Manufacturing Company at Pittsburgh, Pa., in 1886, as assistant electrician, and in1891 was appointed chief electrical engineer. His contributions, as Westinghouse engineer, to the design of the first plant of the Niagara Falls Power Company, Niagara Falls, N. Y., led to his appointment in 1897 as electrical director of that company. In 1900 he began practice as a consulting engineer in New York, N. Y., serving on a number of important engineering projects, notably in connection with railway and urban transit electrification. A leader in the development of alternating current and in the establishment of standard frequencies, he was the author of a number of inventions, including the Stillwell regulator, the time-limit circuit breaker, and the diagrammatic pilot control switchboard. He served the Institute as a director (1896–99), a vice-president (1899–1901), and president (1909–10), and was active on many committees. He was also a past president of the American Institute of Consulting Engineers, a past vice-president of American Engineering Council, and past chairman of Engineering Foundation, and was also a member of the American Society of Civil Engineers, National Academy of Sciences, American Philosophical Society, Franklin Institute, Institution of Electrical Engineers, and Royal Society of Arts, Great Britain. He was awarded the Niagara Medal by the Niagara Falls Power Company in 1899; a medal for "leadership as chairman of Engineering Foundation in consolidating the research work of the Foundation and the founder societies" presented by the

ASCE in 1929; the AIEE Lamme Medal in 1933, and the Edison Medal for 1935. He was a life trustee of Princeton University.

Henry Jones Blakeslee (A'02, M'15) president, The States Company, Hartford, Conn., died January 19, 1941. He was born at Hartford August 15, 1876, and received the degrees of bachelor of science in 1898 and master of science in 1902 from Trinity College. From 1898 to 1900 he was an instructor at Trinity College, Hartford, and for the next three years superintendent of construction for the Hartford Electric Light Company. In 1903 he became electrical inspector for the New England Insurance Exchange, and later for the Underwriters Association of New York State, before becoming electrical engineer and superintendent of the Bureau of Gas and Electricity, City of Syracuse, N. Y., a position which he held from 1907 to 1913. He was one of the founders of The States Company, which was organized in 1911, and first served as treasurer and electrical engineer, later becoming president. He held a number of patents on meter-testing equipment, and was honored in 1940 as a "modern pioneer" by the National Association of Manufacturers.

William Henry Capen (M'23) assistant vice-president and assistant general technical director, International Telephone and Telegraph Corporation, New York, N. Y., died at Orange, N. J., January 15, 1941. He was born August 13, 1890, at Newton, Mass., and received the degrees of bachelor of science, 1913, and master of electrical engineering, 1914, from Harvard University. He entered the employ of Western Electric Company, Inc., New York, N. Y., in 1914, where he specialized in transmission problems. In 1922 he went to Japan as consulting transmission engineer for the company. In 1924 he was transferred to International Western Electric Company, which was later taken over by the International Telephone and Telegraph Corporation. From 1926 to 1929 he was engaged on foreign assignments, including the development of the Japanese telephone system and installation of communications systems for various European governments. Since 1929 he had been assistant vice-president and assistant technical director. He had written technical books and articles.

Charles Austin Greenidge (A'03, M'06, F'13) retired vice-president and chief engineer, Utility Management Corporation, died January 23, 1941, at Cooperstown, N. Y. He was born October 5, 1872, Barbados, British West Indies, and received the degree of mechanical engineer from Stevens Institute of Technology in 1895. In 1896 he was employed by the Mount Morris Electric Company, New York, N. Y., as tester, later becoming acting superintendent. When in 1899 the company was merged into the New York Edison Company, he was appointed assistant district superintendent. He became superintendent of the electric department, Equitable Gas and Electric Company, Utica, N. Y., in 1901, and of the Utica gas and Electric Company in 1902, becoming general manager of the electric department in 1905. About 1910 he became associated with the J. G. White Management Corporation, New York, N. Y., becoming electric lighting manager and later chief engineer. He continued in that position for many years, becoming vice-president of the Utility Management Corporation about 1930. He had retired in 1939.

Daniel M. Wise (M'37) staff supervisor, plant engineering department, American Telephone and Telegraph Company, Philadelphia, Pa., died January 8, 1941. He was born January 29, 1888, at Williamsport, Pa., and received the degree of bachelor of science in electrical engineering from Bucknell University in 1912. He was employed as laboratory assistant, United States Geological Survey, Washington, D. C., and as student apprentice at Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., before becoming magnetic observer for the Carnegie Institution of Washington, D. C., in 1913. He took part in expeditions to Canada, Africa, and South America, and in solar-eclipse expeditions to Lakin, Kans., and Sobral, Brazil, having charge of the latter expedition. He joined the American Telephone and Telegraph Company in 1920, first as an engineer in the long lines department at Harrisburg, Pa., and since 1926 at Philadelphia, where he was division transmission engineer in the long lines department from 1927 to 1940.

Charles Roy Higson (A'21, M'32) consulting engineer, Utah Power and Light Company, Salt Lake City, Utah, died December 18, 1940. He was born August 29, 1883, at Salt Lake City, and received the degrees of bachelor of science, 1907, and electrical engineer, 1911, from the University of Wisconsin. He spent a year in the test department of General Electric Company, Schenectady, N. Y., before becoming an instructor in electrical engineering at the University of Wisconsin, Madison, where he remained until 1911. He entered the operating department of the Utah Light and Traction Company, predecessor of the Utah Power and Light Company, in 1911, and became assistant engineer of the latter company in 1918. He served as superintendent of distribution from 1925 until 1940. He was AIEE vice-president 1932–34, a past chairman of the Utah Section and past president of the Engineering Council of Utah.

Ulrich Joseph Rappel (M'35) professor and head of the department of electrical engineering, University of Dayton, Dayton, Ohio, died September 24, 1940, according to information just received. He was born December 18, 1880, at Chicago, Ill., and received the degrees of bachelor of arts, 1902, and master of arts, 1905, from the University of Dayton, and those of master of science, 1907, and doctor of philosophy, 1909, from the University of Fribourg, Switzerland. He was an assistant in physics at the latter institution 1907–09, and went to the University of Dayton in 1909 as professor of physics. He had headed the electrical-engineering department since 1913. He was also a member of the American Association for the Advancement of Science, Illuminating Engineering Society, and Society for Promotion of Engineering Education.

Membership

Recommended for Transfer

The board of examiners, at its meeting on February 20, 1941, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Affel, H. A., assistant director of transmission development, Bell Telephone Laboratories, Inc., New York, N. Y.
Black, H. S., member technical staff, Bell Telephone Laboratories, Inc., New York.
Bown, Ralph, director of radio and television research, Bell Telephone Laboratories, Inc., New York.
Dodd, R. L., assistant superintendent of electrical construction, Wisconsin Electric Power Company, Milwaukee, Wis.
Friis, H. T., radio research engineer, Bell Telephone Laboratories, Inc., Red Bank, N. J.
Mathes, R. C., associate director of circuit research, Bell Telephone Laboratories, Inc., New York.
Quarles, D. A., director of transmission development, Bell Telephone Laboratories, Inc., New York.
Strieby, M. E., engineer of transmission, American Telephone and Telegraph Company, New York.

8 to Grade of Fellow

To Grade of Member

Benedict, R. R., assistant professor of electrical engineering, University of Wisconsin, Madison, Wis.
Evans, W. H., electrical engineer, Sacramento Northern Railway, San Francisco, Calif.
Gray, L. A., electrical test engineer, Simplex Wire and Cable Company, Cambridge, Mass.
Grimes, C. G., lieutenant commander, United States Navy, Bureau of Ships, Washington, D. C.
Hoffman, K. B., assistant engineer, Consolidated Edison Company of New York, Inc., New York.
Lindemuth, H. F., assistant engineer, Consolidated Edison Company of New York, Inc., New York.
Redding, C. S., president, Leeds and Northrup Company, Philadelphia, Pa.
Rogers, F. H., assistant superintendent, meter and installation department, Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Satterlee, W. W., division engineer, Westinghouse Electric and Manufacturing Company, Sharon, Pa.

9 to Grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical Districts. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before March 31, 1941, or May 31, 1941 if the applicant resides outside of the United States or Canada.

United States and Canada

1. North Eastern

Abbott, C. T., Cambridge Electric Light Company, Cambridge, Mass.
Anderson, J. P., General Electric Company, Schenectady, N. Y.
Autuori, V. A., Southern New England Telephone Company, Bridgeport, Conn.
Bangs, W. A., Central New York Power Corporation, Syracuse, N. Y.
Beebe, M. F., United Illuminating Company, New Haven, Conn.
Black, T. L., General Electric Company, Pittsfield, Mass.
Boyles, R. L., General Electric Company, Schenectady, N. Y.
Brown, J. J. W., General Electric Company, Schenectady, N. Y.
Buckley, J. J., General Electric Company, Schenectady, N. Y.
Busch, F. H., General Electric Company, Lynn, Mass.
Butcher, R. O., General Electric Company, Lynn, Mass.
Byrnes, L. M., Central New York Power Corporation, Syracuse, N. Y.

Byron, K. D., General Electric Company, Schenectady, N. Y.
Canada, A. H., General Electric Company, Schenectady, N. Y.
Denby, H. H., Colonial Radio Corporation, Buffalo, N. Y.
Doddamuniswamappa, N., General Electric Company, Schenectady, N. Y.
Doxey, G. A., General Electric Company, Schenectady, N. Y.
Easton, I. G., General Radio Company, Cambridge, Mass.
Evans, H. R. (Member), General Electric Company, Pittsfield, Mass.
Fernald, A. E., General Electric Company, Lynn, Mass.
Fischer, E. E., Holtzer-Cabot Electric Company, Roxbury, Mass.
Floring, C. W., Central New York Power Company, Syracuse, N. Y.
Gettys, B., General Electric Company, Pittsfield, Mass.
Gorman, R. E., General Electric Company, Lynn, Mass.
Greenleaf, N. P., Central New York Power Corporation, Syracuse, N. Y.
Guilfoos, L. J., War Department, Rochester Ordnance District, Rochester, N. Y.
Hammond, R. L., General Electric Company, Schenectady, N. Y.
Harvey, A. L., United States Army, Plattsburg Barracks, N. Y.
Helin, C. J., Bagley and Sewall Company, Watertown, N. Y.
Hoffman, C. H., Massachusetts Institute of Technology, Cambridge, Mass.
Howland, H. W., General Electric Company, Pittsfield, Mass.
Hubbard, F. A., New Bedford Gas and Edison Light Company, New Bedford, Mass.
James, G. E., General Electric Company, Schenectady, N. Y.
Kalb, J. W., General Electric Company, Pittsfield, Mass.
Keen, R. N., General Electric Company, Pittsfield, Mass.
Kehoe, E. A., General Motors Corporation, Rochester N. Y.
Kelley, H. E., General Electric Company, West Lynn, Mass.
Kelly, P. E., Central New York Power Corporation, Syracuse, N. Y.
Kenney, H. M., General Electric Company, Lynn, Mass.
Knight, C. R., General Electric Company, Schenectady, N. Y.
Koon, K. S., International Business Machine Corporation, Endicott, N. Y.
Korneke, P. B., Jr., General Electric Company, Schenectady, N. Y.
Krause, L. O., General Electric Company, Schenectady, N. Y.
Kunz, L. C., Jr., General Electric Company, Schenectady, N. Y.
Lang, R. R., General Electric Company, Schenectady, N. Y.
Laue, E. G., General Electric Company, Schenectady, N. Y.
Lavoo, N. T., General Electric Company, Schenectady, N. Y.
Leitzke, V. A., General Electric Company, Pittsfield, Mass.
Lister, C. A., General Electric Company, Schenectady, N. J.
Lommen, M. A. K., General Electric Company, Schenectady, N. Y.
MacEwan, A., Jr., Lynn Gas and Electric Company, Lynn, Mass.
Madsen, J. R., General Electric Company, Schenectady, N. Y. (for mail: 88 Monroe Place, Bloomfield, N. J.).
Maleck, J. C., General Electric Company, Schenectady, N. Y.
Manoogian, H., Pacific Mills, Lawrence, Mass.
Martin, D. W., General Electric Company, Schenectady, N. Y.
Martinez, S., Jr., General Electric Company, Schenectady, N. Y.
Mason, H. J., General Electric Company, Pittsfield, Mass.
Mathisen, M. E., General Electric Company, Schenectady, N. Y.
McGovern, A. D., United Illuminating Company, Bridgeport, Conn.
McMillan, F. R., General Electric Company, Schenectady, N. Y.
Mellion, H. H, Central New York Power Corporation, Syracuse, N. Y.
Morse, F. A., Jackson and Moreland, Boston, Mass.
Mulhern, M. J., Central New York Power Corporation, Potsdam, N. Y.
Nelson, R. A., General Electric Company, Pittsfield, Mass. (for mail: 210 E. Forrest Hill, Peoria, Ill.).
Olney, F. D., Jr., General Electric Company, Schenectady, N. Y.
O'Neill, P. F., Central New York Power Corporation, Syracuse, N. Y.
Parent, R. J., General Electric Company, Schenectady, N. Y. (for mail: High Falls, Crivitz, Wis.).
Pearson, D. B., General Electric Company, Schenectady, N. Y. (for mail: New Sweden, Maine).
Pearson, F. A., Central New York Power Corporation, Syracuse, N. Y.
Peck, D. S., General Electric Company, Schenectady, N. Y.
Philbin, T. R., Jr., Connecticut Light and Power Company, Essex, Conn.
Popp, J. M., General Electric Company, Schenectady, N. Y.
Poulsen, G. G., General Electric Company, Pittsfield, Mass.
Prechter, R. R., General Electric Company, Pittsfield, Mass.
Quayle, W., United States Navy, Buffalo, N. Y.
Redmond, J. J., General Electric Company, Lynn, Mass.
Reitz, H. N., Jr., Hamilton Standard Propellers, East Hartford, Conn.
Rhodes, E. K., Central New York Power Corporation, Syracuse, N. Y.
Rice, E. K., Westinghouse Electric and Manufacturing Company, Buffalo, N. Y.
Ridgway, W., General Electric Company, Schenectady, N. Y.
Rives, F. M. (Member), General Electric Company, Schenectady, N. Y.
Robinson, A. W., General Electric Company, Schenectady, N. Y.
Rohloff, H. E., Southern New England Telephone Company, New Haven, Conn.
Rosenkrans, F. A., General Electric Company, Lynn, Mass.
Rowe, S. H., General Electric Company, Schenectady, N. Y.
Schmitt, D. J., General Electric Company, Schenectady, N. Y.
Sherman, K. L., Central New York Power Corporation, Syracuse, N. Y.
Smith, E. P., American Steel and Wire Company, Worcester, Mass.
Solberg, W. O., General Electric Company, Pittsfield, Mass.
Stawicki, S. W., Champion Radio Works, Danvers, Mass.
Suits, C. G. (Member), General Electric Company, Schenectady, N. Y.
Taylor, J. A., Jr., General Electric Company, Schenectady, N. Y.
Thompson, F., General Electric Company, Schenectady, N. Y.
Toman, W. J. V., Colonial Radio Corporation, Buffalo, N. Y.
Townsend, C. W., Central New York Power Corporation, Syracuse, N. Y.
Tracy, J. F., General Electric Company, Schenectady, N. Y.
Turner, H. P., Westinghouse Electric and Manufacturing Company, Providence, R. I.
Vigour, H. E., General Electric Company, Schenectady, N. Y.
Wallace, D. E., General Electric Company, Schenectady, N. Y.
Warnock, W. J., General Electric Company, Schenectady, N. Y.
White, A., General Electric Company, West Lynn, Mass.
Whitehead, D. L., Cornell University, Ithaca, N. Y.
Wilkinson, J. W., General Electric Company, Pittsfield, Mass.
Williams, D. J. (Member), Central New York Power Corporation, Syracuse, N. Y.
Williams, G. R., Light and Power Department, Watertown, N. Y.
Woodward, L. J., Jr., General Electric Company, Schenectady, N. Y.

2. Middle Eastern

Abel, J. E., New York Shipbuilding Corporation, Camden, N. J.
Adams, E. F., Westinghouse Electric and Manufacturing Company, Wilkinsburg, Pa.
Adams, M. J., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Ankenbrandt, O. F., Ohio Bell Telephone Company, Cleveland, Ohio.
Aron, N., United States Navy, Baltimore, Md.
Ashley, G. W. (Member), Philco Corporation, Philadelphia, Pa.
Atkinson, J. F., Rural Electrification Administration, Washington, D. C.
Bailey, J. R., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Barth, G. R., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Bedford, S. M., Jr., Chesapeake and Potomac Telephone Company of West Virginia, Clarksburg, W. Va.
Berry, H. A., Appalachian Electric Power Company, Cabin Creek, West Va.
Best, R. R., Ohio Bell Telephone Company, Cleveland, Ohio.
Bethea, W. H., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Borgstadt, R. D., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Breland, C. G., Navy Department, Washington, D. C.
Brenner, W. C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Brou, E., Naval Aircraft Factory, Philadelphia, Pa.
Brown, R. H., Union Switch and Signal Company, Swissvale, Pa.
Brown, W. C., General Electric Company, Erie, Pa.
Bubaltz, R. E., General Motors Corporation, Trenton, N. J. (for mail: 427 Louisa St., South Amboy, N. J.).
Buchholtz, H. C., United States Naval Academy, Annapolis, Maryland.
Buess, L. E., Chesapeake and Potomac Telephone Company of West Virginia, Charleston, W. Va.
Bungarda, G. A., American Telephone and Telegraph Company, Cleveland, O.
Byrum, J. F., Bethlehem Steel Company, Sparrows Point, Md.
Carbrey, R. L., Bell Telephone Laboratories, Incorporated, Baltimore, Md.
Cardwell, G. P., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Carpenter, C. E., General Electric Company, Philadelphia, Pa.
Cartwright, A. N. (Member), West Penn Power Company, Pittsburgh, Pa.
Case, S. R., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Chappuis, C. K., Putnam and Woolpert, Dayton, Ohio.
Chase, W. H. (Member), Ohio Bell Telephone Company, Cleveland, Ohio.
Clevenger, L. M., III, Sun Shipbuilding and Dry Dock Company, Chester, Pa.
Coleman, J. T., Jr., General Electric Company, Philadelphia, Pa.
Cooke, T. L., Jr., Austin Company, Cleveland, O.
Cooper, F. E., Westinghouse Electric and Manufacturing Company, Cleveland, Ohio.
Cooper, T. D., United States Government, Navy Department, Washington, D. C.
Corl, W. F., Jr., Philadelphia Electric Company, Philadelphia, Pa.
Cox, F., Metropolitan Edison Company, Easton, Pa.
Crane, L. R., Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.
Dagan, I., General Motors Corporation, Dayton, O.
Daley, C. M., Jr., Philadelphia Electric Company, Philadelphia, Pa.
Dannettell, A. C., Yale & Towne Manufacturing Co., Philadelphia, Pa.
Davis, A., Jr., Westinghouse Electric and Manufacturing Company, Wilkinsburg, Pa. (for mail: Box 83, Johnson City, Texas).
Denton, R. H., Bureau of Ordnance, Navy Department, Washington, D. C.
Dingle, R. L., Taylor-Winfield Corporation, Warren, Ohio.
Dorsey, G. A., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Drescher, L. L., Synchro-Start Products, Incorporated, Toledo, Ohio.
Edwards, R. F., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Egeler, C. E. (Member), General Electric Company, Nela Park, Cleveland, O.
Erdmann, L., Philadelphia Electric Company, Philadelphia, Pa.
Erhard, R., Jr., The Jefferson Company, Smithfield, Ohio.
Fawcett, E. C., E. I. du Pont de Nemours and Company, Wilmington, Del.
Ferguson, S. A., Westinghouse Electric and Manufacturing Company, Wilkinsburg, Pa.
Finch, R. E., United States Government, Navy Department, Washington, D. C.
Ford, J. G., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Foster, M. C., United States Army, Aberdeen Proving Ground, Md.
Frazee, H., Joy Manufacturing Company, Franklin, Pa.
Friedman, A. B., Allis-Chalmers Manufacturing Company, Pittsburgh, Pa.
Friedman, M. H., Bureau of Ordnance, Navy Department, Washington, D. C.
Frus, H. G., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Fry, F. J., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Gahm, W. L., United States Naval Aircraft Factory, Philadelphia, Pa.
Gaines, S., Jr., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Gardiner, R. A., General Industries Company, Elyria, O.
Gilliam, A. A., Howard University Power Plant, Washington, D. C.
Golasky, F. W., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Goldwag, H., Office of the Chief Signal Officer, War Department, Washington, D. C.
Goody, R. B., Gibson Electric Company, Pittsburgh, Pa.
Grasser, H. A., Toledo Edison Company, Toledo, Ohio.
Gund, R. A., General Electric Company, Philadelphia, Pa. (for mail: 4344 Wilcox Avenue, St. Louis, Mo.).
Hague, C. S., Jr., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Hemerich, H. A., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Helwig, F. C. (Member), Toledo Edison Company, Toledo, Ohio.
Herr, C. E., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Hess, E. L., Bethlehem Steel Company, Bethlehem, Pa.
Honsinger, V. B., Ideal Electric and Manufacturing Company, Mansfield, O.
Hood, L. E., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Hornstein, I., Babcock and Wilcox Company, Barberton, Ohio.
Housley, D. G., Rural Electrification Administration, Washington, D. C.
Jenkins, R. M., Duquesne Light Company, Pittsburgh, Pa.
Jennings, J., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Jensen, H. E. (Member), Philco Corporation, Philadelphia, Pa.
Jones, I. K., American Telephone and Telegraph Company, Washington, D. C.
Kaiser, F. D., Westinghouse Electric and Manufacturing Company, Sharon, Pa.

Kaminski, J., Rural Electrification Administration, Washington, D. C.
Kazda, L. F., G. A. Gray Company, Cincinnati, Ohio.
Kempton, L. R., United States Army, Washington, D. C.
Kienzle, C. A., Philadelphia Electric Company, Philadelphia, Pa.
Kirsch, W. A., Carnegie Illinois Steel Corporation, Clairton, Pa.
Klein, L., Jr., Glenn L. Martin Company, Baltimore, Md.
Kozuchowski, W. J., Western Electric Company, Baltimore, Md.
Lash, J. C., The Cleveland Graphite Bronze Company, Cleveland, Ohio.
Lee, W. H., Electric Products Company, Cleveland, O.
Leemon, W., Ohio Bell Telephone Company, Cleveland, O.
Leise, M. S., Rural Electrification Administration, Washington, D. C.
Leithold, N. T., Adelphia Electric Company, Philadelphia, Pa.
Lloyd, K. H., Philadelphia Electric Company, Philadelphia, Penna.
Lyman, L. L., Austin Company, Cleveland, O.
Lynn, L. B., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Marshall, J. C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Matthews, A. R., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. (for mail: 6 South Palouse Street, Walla Walla, Washington).
Mayoral, G. A., Crosley Radio Corporation, Station WLW, Cincinnati, O.
McClung, J. D., Koppers Coal Company, Fairview, W. Va.
McKee, C. G., Pennsylvania Power Company, New Castle, Pa.
Messmer, G. R., Rural Electrification Administration, Washington, D. C.
Michalowicz, J. C., Rural Electrification Administration, Washington, D. C.
Miller, D. M., Appalachian Electric Power Company, Huntington, W. Va.
Mitchell, F. T., Jr., Jansky and Bailey, Washington, D. C.
Myers, A. J., Jr., Rural Electrification Administration, Washington, D. C.
Norton, K. A., Federal Communications Commission, Washington, D. C.
Nurches, P., WADC Broadcasting Station, Akron, Ohio.
Oien, P. O., General Electric Company, Erie, Pa.
Olyarnik, E. N., Babcock and Wilcox Company, Barberton, O.
Osbon, W. O. (Member), Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Otis, S. J., Rural Electrification Administration, Washington, D. C.
Palmer, V. L., Civil Aeronautics Administration, Washington, D. C.
Parnell, J., Leeds and Northrup Company, Philadelphia, Pa.
Parton, C. A., Westinghouse Electric and Manufacturing Company, Lima, Ohio.
Pasco, T. G., Leece-Neville Company, Cleveland, Ohio.
Perkins, C. W., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Pfaff, R. W. (Member), Philadelphia Electric Company, Philadelphia, Penna.
Pierce, J. D., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Queen, S. D., Cleveland Electric Illuminating Company, Ashtabula, O.
Ramsay, W. L., New York Shipbuilding Corporation, Camden, N. J.
Ranz, F. S., R. K. LeBlond Machine Tool Company, Cincinnati, O.
Ringe, G. T., Jr., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Roach, D. D., Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.
Rutledge, J. C., Leeds and Northrup Company, Philadelphia, Pa.
Sauer, L. E. (Member), Westinghouse Electric and Manufacturing Company, Sharon, Penna.
Scholz, W. E., Philadelphia Electric Company, Philadelphia, Pa.
Schroeder, D. J., Westinghouse Electric and Manufacturing Company, Sharon, Penna.
Schweder, W. M., 2nd Lieutenant, Ordnance Department, United States Army, Pedricktown, N. J.
Seeskin, P., Dayton Power and Light Company, Dayton, Ohio.
Sellers, A. H., Philadelphia Electric Company, Philadelphia, Pa.
Sen, W. J., Aircraft Radio Laboratory, War Department, Dayton, O.
Serrill, J. L., Jr., Leeds and Northrup Company, Philadelphia, Penna.
Shirland, F. A., Jr., National Carbon Company, Incorporated, Fostoria, O.
Shorter, O. L., Jr., General Electric Company, Philadelphia, Pa.
Shulman, J. M., Westinghouse Electric and Manufacturing Company, Lima, Ohio.
Siehr, V. P., Bell Telephone Company of Pennsylvania, Philadelphia, Pa.
Sizemore, C. (Member), District Pumping Station, Washington, D. C.
Skone, R. L., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Sneed, A. B., Appalachian Electric Power Company, Bluefield, W. Va.
Snyder, K. G., Bethlehem Steel Company, Steelton, Pa.
Soper, F. W., Cleveland Electric Illuminating Company, Cleveland, O.
Spandau, E. P., George Worthington Company, Cleveland, Ohio.
Squires, R. B., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Steffey, W. J., Duquesne Light Company, Pittsburgh, Pa.
Storrs, G. H., Glen L. Martin Company, Baltimore, Md.
Strasburg A. C., War Department, Aberdeen, Md.
Summers, C. L., Westinghouse Electric and Manufacturing Company, Wilkinsburg, Pa.
Swarm, H. M., Civil Aeronautics Administration, Washington, D. C.
Talley, H. J. (Member), American Telephone and Telegraph Company, Philadelphia, Pa.
Terkanian, H., War Department, Signal Corps Equipment, Dayton, O.
Thomas, H. W., United States Army, Allentown, Penna.
Thurston, J. L., Rural Electrification Administration, Washington, D. C.
Vetter, J. A., Koppers Company, Pittsburgh, Pa.
Voss, R. I., Philadelphia Electric Company, Philadelphia, Pa.
Wadsworth, C. V., Electric Controller and Manufacturing Company, Cleveland, O.
Webb, Mrs. H. J., 1315 Everett Street, Wilkinsburg, Pa.
Webb, H. J., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Wheeler, E., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
White, J. H., Cincinnati Gas and Electric Company, Cincinnati, Ohio.
Williams, J. S., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Williams, L. I., University of Pittsburgh, Pittsburgh, Pa.
Williams, S. L., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Williamson, C. N., Navy Department, Washington, D. C.
Williston, C. A., Yoder Machine Company, Cleveland, O.
Young, P. G., Washington Institute of Technology, Washington, D. C.
Zimmerman, W. O., Jr., Duquesne Light Company, West Bridgewater, Pa.

3. New York City

Amend, A., Jr., General Time Instruments Corporation, New York, N. Y.
Auditore, C. J., International Business Machines Corporation, New York, N. Y.
Berglund, P. T., Eclipse Aviation Corporation, East Orange, N. J.
Bulloch, G. E. (Member), New Jersey Bell Telephone Company, Newark, N. J.
Carlin, H. J., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Carlson, A. V., S. S. White Dental Manufacturing Company, Staten Island, N. Y.
Chirles, A. M., Airlines Terminal, New York, N. Y.
Coppola, R. J., General Instrument Corporation, Elizabeth, N. J.
Deamant, F. H., Board of Transportation, New York, N. Y.
DeMott, E. G., Weston Electrical Instrument Corporation, Newark, N. J.
Dingenthal, J., United States Government, Navy Department, c/o Supervisor of Shipbuilding, New York, N. Y.
Dombroski, S. J., Westinghouse Electric and Manufacturing Company, Newark, N. J.
Emmons, H. L., Jr., Jamesburg, N. J.
Frank, H. C. (Member), General Cable Corporation, Bayonne, N. J.
Garbarini, R. F., Empire Electric Brake Company, Newark, N. J.
Gessert, E. C., Jr., American Telephone and Telegraph Company, New York, N. Y.
Hagopian, J. J., War Department, New York Signal Corps, Procurement District, Brooklyn, N. Y.
Harrington, A. W., Jr., United States Army, Fort Monmouth, N. J.
Hauck, O. A., Grumman Aircraft Company, Bethpage, L. I., N. Y.
Hendrickson, J. G., War Department, New York Signal Corps, Procurement District, Brooklyn, N. Y.
Higgins, L. J. P., New York City Department Water Supply Gas and Electric, New York, N. Y.
Hough, R. R., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Ketiladze, G. S., 480 Lexington Avenue, New York, N. Y.
Klein, M., Stevens Institute of Technology, Hoboken, N. J.
Kohler, G. M., Jr., Curtiss Wright Corporation, Caldwell, N. J.
Koppelon, R., 92 Vassar Avenue, Newark, N. J.
Kunc, F. (Member), H. O. Boehme Incorporated, New York, N. Y.
Lund, H. A. (Member), New York Telephone Company, New York, N. Y.
Lurch, E. N., International Telephone and Telegraph Corporation, International Standard Electric Corporation, New York, N. Y.
Madill, J. T., Ebasco Services Inc., New York, N. Y.
Markosian, V., General Electric Company, Newark, N. J.
McCalip, C. E., Jr., Consolidated Edison Company of New York, Incorporated, New York, N. Y.
McCleece, H. M., Consolidated Edison Company of New York City, Inc., New York, N. Y.
Meyer, H. O., Federal Shipyard and Dry Dock Company, Kearny, N. J.
Milarta, L. E., Bell Telephone Laboratories Incorporated, New York, N. Y.
Miller, K. W., United States Army, Signal Corps, Fort Monmouth, N. J.
Miller, T. S., Jr., New York Telephone Company, New York, N. Y.
Mills, J. K., United States Army, Ordnance Department, Raritan Arsenal, Metuchen, N. J.
Moore, J. B. (Member), R.C.A. Communications, Inc., Riverhead, L. I., N. Y.
Morrison, J. F. (Member), Bell Telephone Laboratories, Incorporated, Whippany, N. J.
Nicolosi, J. P., Wright Aeroplane Corporation, Paterson, N. J.
Orlowski, W. F., American Transformer Company, Newark, N. J.
Overman, F. B., Jr., Underwriters' Laboratories, Incorporated, New York, N. Y.
Perini, F. A., Ward Leonard Electric Company, Mt. Vernon, N. Y.
Piatt, W. M., III, Rutgers University, New Brunswick, N. J.
Potter, J. L., Rutgers University, New Brunswick, N. J.
Pulhamus, W. R., Federal Shipbuilding and Drydock Company, Kearny, N. J.
Richardson, P. H., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Rissberger, J. G., Bureau of Ships, United States Navy Department, New York, N. Y.
Rounds, P. W., Bell Telephone Laboratories Incorporated, New York, N. Y.
Sayre, J. E., Newark College of Engineering, Newark, N. J.
Scharmann, R. F., National Union Radio Corporation, Newark, N. J. (for mail: 1 Kenwood St., Pittsfield, Mass.).
Sherwin, J. P., Curtiss-Wright Corporation, Caldwell, N. J.
Stailing, G. E., Phelps Dodge Corporation, Elizabeth, N. J.
Stammerjohn, L. W., Bell Telephone Laboratories, New York, N. Y.
Sturgeon, W. S., Consolidated Edison Company of New York, Incorporated, New York, N. Y.
Sumner, R. J., City of New York, Department of Public Works, New York, N. Y.
Tenzer, M., War Department, New York Signal Corps, Procurement District, Brooklyn, N. Y.
Vissers, W., Jr., Radiomarine Corporation of America, New York, N. Y.
Vitale, S. A., American Telephone and Telegraph Company, New York, N. Y.
Wendel, L. A., Diehl Manufacturing Company, Elizabethport, N. J.
Weng, H. C., Harmon Foundation, Incorporated, New York, N. Y.
Westover, T. A., Public Service Electric and Gas Company, Irvington, N. J.
Wolstenholme, W. E., United States Rubber Company, Passaic, N. J.
Wootton, J. C., New York Telephone Company, New York, N. Y.

4. Southern

Barden, J. F., Jr., Atlantic Coast Line Railroad Company, Rocky Mount, N. C.
Bateman, F. F., Southern Bell Telephone and Telegraph Company, Columbia, S. C.
Blackstock, R., United States Army Air Corps, Coral Gables, Fla. (for mail: 180 Seventh Avenue, Brooklyn, N. Y.).
Bonnette, I. T., Carter Oil Company, Winnfield, La.
Callison, R. L., United States Army Air Corps, Montgomery, Ala.
Cantrell, S. W., Memphis Light Gas and Water Division, Memphis, Tenn.
Cheek, J. H., Jr., Pantops Farm, Charlottesville, Va.
Cronvich, J. A., Tulane University, New Orleans, La.
Dale, H. L., United States Navy Department, Portsmouth, Va.
Evans, R. D., The Okonite Company, Atlanta, Ga.
Fisher, E. W. (Member), War Department, U. S. Engineer Office, Brookley Field, Mobile, Ala.
Fletcher, R. A., U. S. Navy Department, Portsmouth, Va.
Fletcher, S. H., Virginia Public Service Company, Harrisonburg, Va.
Gore, J. P., Duke Power Company, Greenville, S. C.
Hall, C. N., United States Army, Fort Knox, Kentucky.
Hodges, R. C. (Member), Virginia Public Service Company, Arlington, Va.
Huff, V. N., National Advisory Committee for Aeronautics, Langley Field, Va.
Kelsall, A. C., Louisville Gas and Electric Company, Louisville, Ky.
Librizzi, P. N., United States Army, Fort Benning, Ga.
Manning, L. W., Nantahala Power and Light Company, Franklin, N. C.
Moncure, M. W. (Member), Public Works Office, Quantico, Va.
Muller, H. L., Maritime Electric Company, Incorporated, New Orleans, La.
Nelson, B. E., United States Army, Fort Jackson, S. C.
Nussbaum, C. W., D. T. Odom Electric Company, New Orleans, La.
Powell, L., Jr., Virginia Public Service Company, Clifton Forge, Va.

Rose, C. G., Joseph E. Seagram and Sons Company, Incorporated, Louisville, Ky.
Russell, J. D., Jr., Ken-Rad Tube and Lamp Company, Owensboro, Ky.
Sandidge, W. L., Virginia Public Service Company, Clifton Forge, Va.
Siler, H. K., Robert and Company, Jacksonville, Fla.
Skoog, R. K., National Advisory Committee for Aeronautics, Langley Field, Va.
Spain, W. M., Tennessee Powder Company, Millington, Tenn.
Wilson, J. L., Jr., Southern Bell Telephone and Telegraph Co., Atlanta, Ga.

5. Great Lakes

Altman, N. P., Holabird and Root, Chicago, Ill.
Appleyard, R. E., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Aynes, M. F., Louis Allis Company, Milwaukee, Wisconsin.
Beachum, J. H., Jr., Monsanto Chemical Company, Monsanto, Ill.
Beem, F. A., Illinois Bell Telephone Company, Springfield, Ill.
Berry, J. H., Public Utility Engineering and Service Corporation, Chicago, Ill.
Bloodworth, T. H., Allis-Chalmers Manufacturing Company, West Allis, Wis.
Boncyk, C. J., Interstate Power Company, Dubuque, Iowa.
Boyer, K. L., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Byrne, C. J., Jr., Jefferson Electric Company, Bellwood, Illinois.
Camras, M., Armour Research Foundation, Chicago, Ill.
Cline, E. W., Commonwealth Edison Company, Chicago, Ill.
Connelly, B. J., Minerallac Electric Company, Chicago, Ill.
Cooper, J. K., Square D Company, Detroit, Mich.
Danforth, N. L., Jr., Allis-Chalmers Manufacturing Company, West Allis, Wis.
Daniels, L. H., General Motors Corporation, Grand Rapids, Mich.
Dicke, B. C., Firm of J. S. Hartt, Madison, Wis.
DiVito, N. J., Continental Steel Corporation, Kokomo, Ind.
Dupuis, H. P., Commonwealth and Southern Corporation, Jackson, Mich.
Elbourn, R. D., C. G. Conn, Ltd., Elkhart, Ind.
Ellison, N. D., Jr., Detroit Public Lighting Commission, Detroit, Mich.
Farr, W. H., Stewart Warner Corporation, Chicago, Ill.
Ferrara, G. E., Don C. Campion Laboratories, Detroit, Mich.
Fisher, F. H., Delco Remy Corporation, Anderson, Ind.
Fluehr, G. R., Kuhlman Electric Company, Bay City, Mich.
Foute, H. K., Drake Manufacturing Company, Chicago, Ill.
Harolds, O. S., Commonwealth Edison Company, Chicago, Ill.
Hayhurst, T. E., Fairbanks Morse Company, Beloit, Wis.
Heffelfinger, J. B., Collins Radio Company, Cedar Rapids, Iowa.
Herdman, D. F., Commonwealth Edison Company, Chicago, Ill.
Hilt, W. M., Westinghouse Electric and Manufacturing Company, Chicago, Ill.
Himelmayr, F. A., Bendix Aviation Corporation, South Bend, Ind.
Horn, E. H., Carnegie-Illinois Steel Corporation, Gary, Ind.
Howe, N. H., Dow Chemical Company, Midland, Michigan.
Humm, D. L., Illinois Testing Laboratories, Incorporated, Chicago, Ill.
Jackson, C. H., Purdue University, W. Lafayette, Ind.
Johnson, H. J. (Member), Commonwealth Edison Company, Chicago, Ill.
Johnson, J. E., Interstate Power Company, Dubuque, Iowa (for mail: 810 N. Main Street, Harrisburg, Ill.).
Johnson, R. C., Bryant Paper Company, Kalamazoo, Michigan.
Kennel, B. W., Russel Electric Company, Chicago, Ill.
Kotila, O. W. (Member), Copper District Power Company, Ontonagon, Mich.
LaHue, P. M., Brunswick, Balke, Collender Company, Muskegon, Mich.
Logan, J. A., Jr., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
March, N. E., Chrysler Institute, Highland Park, Michigan.
Maury, T. E., Western United Gas and Electric Company, Aurora, Illinois.
Menard, E. G., Allis-Chalmers Company, West Allis, Wis.
Miller, O. J. (Member), Commonwealth and Southern Corporation, Jackson, Mich.
Moody, R. H., Westinghouse Electric and Manufacturing Company, Chicago, Ill.
Moore, R. S., Fairbanks-Morse and Company, Chicago, Ill.
Myron, G. M., Michigan Bell Telephone Company, Port Huron, Mich.
Nelson, R. F., Michigan State College, East Lansing, Mich.
Painter, R. O., General Motors Proving Ground, Milford, Michigan.
Peck, D. F., Barber-Colman Company, Rockford, Ill.
Pogorzelski, R., Wayne University, Detroit, Michigan.
Qualls, W. F., II, Grand Rapids Stamping Division, General Motors, Grand Rapids, Mich.
Rann, R. H., Electromotive Corporation, La Grange, Ill.
Rice, R. E., Minneapolis Honeywell Regulator Company, Minneapolis, Minn.
Rich, F. W., Commonwealth and Southern Corporation, Jackson, Mich.
Richards, E. E., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Robbins, R. D., Indiana Associated Telephone Corporation, Lafayette, Indiana.
Russell, H. E., Diamond Chain and Manufacturing Company, Indianapolis, Ind.
Sarbacher, R. I. (Member), Illinois Institute of Technology, Chicago, Ill.
Schwarz-Kast, E. L., Armour Research Foundation, Chicago, Ill.
Schweitzer, E. O., Jr., War Department, United States Signal Section, Northbrook, Ill.
Scott, F. M., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Shirkey, P. C., Jr., Inland Steel Company, Indiana Harbor, Ind.
Slaybaugh, L., Kellogg Company, Battle Creek, Michigan.
Smith, W. L., Commonwealth Edison Company, Chicago, Ill.
Spreuer, W. E., Shipshewana, Indiana.
Sturgis, C. P., Commonwealth Edison Company, Chicago, Ill.
Tones, T. E., General Motors Corporation, Detroit, Michigan.
Triplett, P., Allis-Chalmers Manufacturing Company, West Allis, Wis.
Veras, A. F., Commonwealth Edison Company, Chicago, Ill.

6. North Central

Abbott, J. G. (Member), Mech Lectric, Omaha, Nebr.
Alexander, J. W., Rawlins Electric Company, Rawlins, Wyoming.
Cox, E. H., Westinghouse Electric and Manufacturing Company, Denver, Colo.
Miller, N. H., Miller Electric Company, Omaha, Nebr.
Rice, F. J., Electric Products Company, Minot, N. Dak.
Schwalb, W. R., University of Denver, Denver, Colorado.
Stauffer, L. M. (Member), General Electric Company, Denver, Colo.

7. South West

Alexander, K. E., Sheffield Steel Corporation, Kansas City, Mo.
Althaus, E. J., Emerson Electric Manufacturing Company, St. Louis, Mo.
Brands, J. T., Texas Power and Light Company, McKinney, Texas.
Doll, H. G. (Member), Schlumberger Well Surveying Corporation, Houston, Texas.
Elder, F. L., Arkansas-Missouri Power Corporation, Blytheville, Ark.
Farrington, W. H., Texas Electric Service Company, Fort Worth, Texas.
Gibson, G. B., H. B. Gieb and Company, Dallas, Texas.
Goodson, B. F., Texas Power and Light Company, Tyler, Texas.
Hammond, L. R., Jr., Phelps Dodge Refining Corporation, El Paso, Texas.
Hollingsworth, W. R., Westinghouse Electric and Manufacturing Company, Houston, Texas.
Hunter, C. E., American Telephone and Telegraph Company, Wichita, Kansas.
Jablonsky, R. D., Union Electric Company of Missouri, St. Louis, Mo.
Johnson, L. E., New Mexico State College, State College, New Mexico.
Jones, R. H., Jr., Moloney Electric Company, St. Louis, Mo.
Jones, T. L., Southwestern Bell Telephone Company, St. Louis, Mo.
Koch, A. R., Jr., Bussmann Manufacturing Company, St. Louis, Mo.
Michael, R. R., Social Security Board, United States Government, Dallas, Texas.
Neblett, P. S., Texas Power and Light Company, Dallas, Texas.
Neubauer, W. H., Petty Geophysical Engineering Company, San Antonio, Texas.
Schneider, F. T., Jr., United States Army, Fort Riley, Kansas.
Smith, R. M., Bureau of Bridges, Jefferson City, Mo.
Sullivan, R. L., Transcontinental and Western Air, Incorporated, Kansas City, Mo.
Townsend, C. C., United States Army, Fort Sill, Okla.
Westin, C. L. (Member), Westinghouse Electric and Manufacturing Company, St. Louis, Mo.
Williams, J. L., Brown and Bellows, Corpus Christi, Texas.
Wray, H. H., Dallas Power and Light Company, Dallas, Texas.
Wright, S. C., Southwestern Bell Telephone Company, Tulsa, Okla.

8. Pacific

Carpenter, C. A., Lockheed Aircraft Corporation, Burbank, Calif.
Correy, T. B., Square D Company, Los Angeles, Calif.
Crispell, H. L., Commercial Radio Equipment Company, Hollywood, Calif.
Donovan, H. W., Lockheed Aircraft Corporation, Burbank, Calif.
Hansen, H. M., United States Army, Fort Ord, California.
Held, H. E., Weston Electrical Instrument Corporation, San Francisco, Calif.
Hoag, L. J., Standard Oil Company of California, Richmond, Calif.
Jahn, E. E., Pacific Gas and Electric Company, San Jose, Calif.
Kohler, F. L., United States Army, Monterey, Calif.
Lowe, L. W., Consolidated Aircraft Corporation, San Diego, Calif.
Morton, J. T., Jr., Holmes and Narver, Los Angeles, Calif.
Sandiford, P. L., Jr., Lockheed Aircraft Corporation, Burbank, Calif.
Scheiber, E. J., Mare Island Navy Yard, Vallejo, Calif.
Tudhope, G. V., Jr., City of Oakland, Calif.
Voitoff, G. E., Jacuzzi Brothers, Incorporated, Berkeley, Calif.
Wall, R. A., Southern California Telephone Company, Los Angeles, Calif.
Waters, C. H., San Francisco-Oakland Bay Bridge, Oakland, Calif.

9. North West

Baldwin, F. S., Jobbus Supply Company, Seattle, Wash.
Beck, M. O., Puget Sound Power and Light Company, Olympia, Wash.
Bianchi, R., Montana School of Mines, Butte, Mont.
Davis, B., Deadwood Mine, Cascade, Idaho.
Donaldson, N. E., 1135 West Platinum, Butte.
Eggers, C. C., c/o Construction Quartermaster, Fort Lewis, Wash.
Finlayson, A., United States Navy, Bremerton, Washington.
Hahn, C. C., Boeing Aircraft Company, Seattle, Wash.
Hale, M. S., Puget Sound Power and Light Company, Bremerton, Washington.
Hall, G. J., Idaho Power Company, Boise, Idaho.
Hurlbut, H. C., United States Navy, Seattle, Wash.
Jeffs, T. W., United States Navy, Bremerton, Washington.
Kassens, A. H., Washington Water Power Company, Spokane, Washington.
Laub, J. H., Cache Valley Electric Company, Logan, Utah.
Loveland, R. J., West Coast Telephone Company, Everett, Wash.
Randall, H. L., Radio Station KVI, Vashon Island, Wash.
Richardson, G. G., Idaho Power Company, Twin Falls, Idaho.
Sabo, J. J., The Montana Power Company, Great Falls, Montana.
Schneider, L. W., Washington Water Power Company, Spokane, Washington
Sedam, C. H., Puget Sound Power and Light Company, Seattle, Wash.
Swain, C. W., Boeing Aircraft Company, Seattle, Washington.
Thomson, A., Bonneville Power Administration, Portland, Oregon.
Walker, E., Route 2, Box 68, Beaverton, Ore.
Wiitala, M. F., United States Navy, Bremerton, Wash.

10. Canada

Cosar, J., Canadian Westinghouse Company, Limited, Hamilton, Ont.
Hart, L. K., Canadian General Electric Company Limited, Toronto, Ont.
Jeckell, W. H. R., Canadian National Carbon Company, Limited, Toronto, Ont.
Martin, I. W. M., National Research Council, Ottawa.
Meyer, W. H., Canadian General Electric Company, Toronto, Ont.
Pegler, W. A., Canadian General Electric Company, Limited, Peterboro, Ont.
Pogson, J. R., British Columbia Electric Railway Company, Limited, Victoria, B. C.
Polson, W. A., Defence Industries Limited, Nobel, Ontario.
Ratcliff, J. H. (Member), Canadian General Electric Company, Toronto, Ont.
Rosen, C. A., Fairchild Aircraft Limited, Longueuil, Quebec.
Saito, G., Box 491, Ocean Falls, B. C.
Webb, E. S., British Columbia Electric Railway Company, Limited, Vancouver, B. C.

Total, United States and Canada 533

Elsewhere

Alfaro, H., Jr., c/o Constructing Quartermaster, Albrook Field, Canal Zone.
Alvarado, A., Puerto Rico Housing Authority, San Juan, Puerto Rico.
Casanas, J. A., Jr., School of Tropical Medicine, San Juan, Puerto Rico.
de Quevedo, J. L. G., University of Puerto Rico, Mayaguez, Puerto Rico.
Lugo, E. D., Puerto Rico Advertising Company, Mayaguez, P. R.
Romera, M. G., Centro Superior Tecnologico, Habana, Cuba.

Total, elsewhere, 6

Of Current Interest

Television Standards Submitted to FCC; Hearing to Be Held March 20

THE National Television System Committee, at a conference on January 27, 1941, submitted to the Federal Communications Commission 22 proposed standards for commercial operation of television. Following the conference the FCC announced that a formal public hearing on television would be held March 20, 1941, "for the purpose of considering the various engineering standards that have been suggested, and also to determine when television broadcasting should be placed on a commercial basis."

The committee was created during the summer of 1940 by the television industry in collaboration with the FCC, to seek solutions of the crucial technical problems of television. Its members are the following:

W. R. G. Baker (A'19) General Electric Company, *chairman;* Virgil M. Graham, Emporium, Pa., *secretary;* E. F. W. Alexanderson (F'20) General Electric Company; Ralph Bown (M'30) Bell Telephone Laboratories; B. Ray Cummings (A'18) Farnsworth Television and Radio Corporation; Allen B. DuMont, Allen B. DuMont Laboratories, Inc.; E. W. Engstrom, RCA Manufacturing Company, Inc.; A. N. Goldsmith (F'20) Institute of Radio Engineers; Daniel E. Harnett (M'38) Hazeltine Corporation; John V. L. Hogan (M'20) National Association of Broadcasters; John R. Howland, Zenith Radio Corporation; Albert I. Lodwick, Hughes Tool Company; R. H. Manson (M'18) Stromberg-Carlson Telephone Manufacturing Company; Adrian Murphy, Columbia Broadcasting System; Paul C. Raibourn, Television Productions; David B. Smith, Philco Corporation.

The full text of the committee's report to the FCC follows.

REPORT OF THE COMMITTEE

The National Television System Committee recommends herewith transmission standards for commercial television broadcasting. The committee recognizes the co-ordinate importance of standardization and the commercial application of technical developments now in the research laboratories. These standards will make possible the creation, in the public interest, of a nationally co-ordinated television service and at the same time will insure continued development of the art.

Monochromatic transmission systems other than those embodied in these standards should be permitted to operate commercially, when a substantial improvement would result, provided that the transmission system has been adequately field tested and that the system is adequately receivable on receivers responsive to the then existing standards.

This committee believes that, although color television is not at this time ready for commercial standardization, the potential importance of color to the television art requires that

(*a*). A full test of color on the Group A channels be permitted and encouraged, and that

(*b*). After successful field test, the early admission of color to the Group A channels on a commercial basis coexistent with monochromatic television be permitted, employing the same standards as are herewith submitted except as to lines and frame and field frequencies. The presently favored values for lines, frame and field frequencies for such a color system are, respectively, 343, 60, and 120.

Those transmission standards are recommended for commercial television broadcasting on the following channels:

Channel Number	Megacycles
1	50– 56
2	60– 66
3	66– 72
4	78– 84
5	84– 90
6	96–102
7	102–108

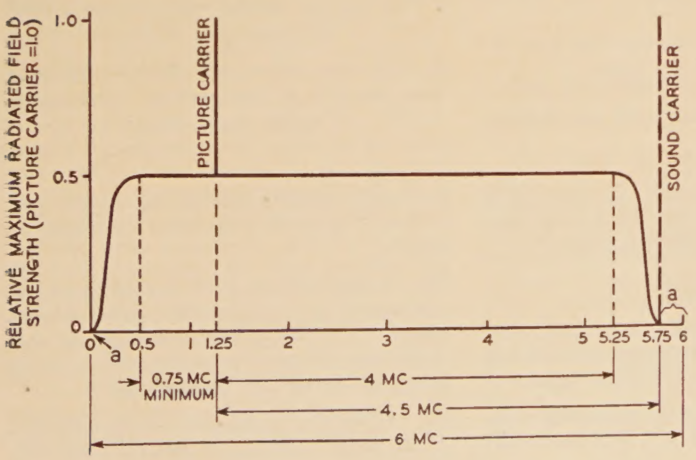


Figure 1. Idealized picture-transmission amplitude characteristic

(*a*)—Relative field strength of picture side band not to exceed 0.0005

Drawing not to scale

I: The Television Channel

1. The width of the standard television broadcast channel shall be 6 megacycles per second.

2. It shall be standard to locate the picture carrier 4.5 megacycles per second lower in frequency than the unmodulated sound carrier.

3. It shall be standard to locate the unmodulated sound carrier 0.25 megacycle per second lower than the upper frequency limit of the channel.

4. The standard picture transmission amplitude characteristic shall be that shown in figure 1.

II: Scanning Specifications

5. The standard number of scanning lines per frame period in monochrome shall be 441, interlaced two to one.

6. The standard frame frequency shall be 30 per second and the standard field frequency shall be 60 per second in monochrome.

7. The standard aspect ratio of the transmitted television picture shall be four units horizontally to three units vertically.

8. It shall be standard, during the active scanning intervals, to scan the scene from left to right horizontally and from top to bottom vertically, at uniform velocities.

III: Picture Signal Modulation

9. It shall be standard in television transmission to use amplitude modulation for both picture and synchronizing signals, the two signals occupying different amplitude ranges.

10. It shall be standard that a decrease in initial light intensity cause an increase in radiated power.

11. It shall be standard that the black level be represented by a definite carrier level, independent of light and shade in the picture.

12. It shall be standard to transmit the black level at 75 per cent (with a tolerance of plus or minus 2.5 per cent) of the peak carrier amplitude.

IV: Sound Signal Modulation

13. It shall be standard to use frequency modulation for the television sound transmission.

14. It shall be standard to pre-emphasize the sound transmission in accordance with the impedance-frequency characteristic of a series inductance-resistance network having a time constant of 100 microseconds.

V: Synchronizing Signals

15. It shall be standard in television transmission to radiate the synchronizing wave form shown in figure 2.

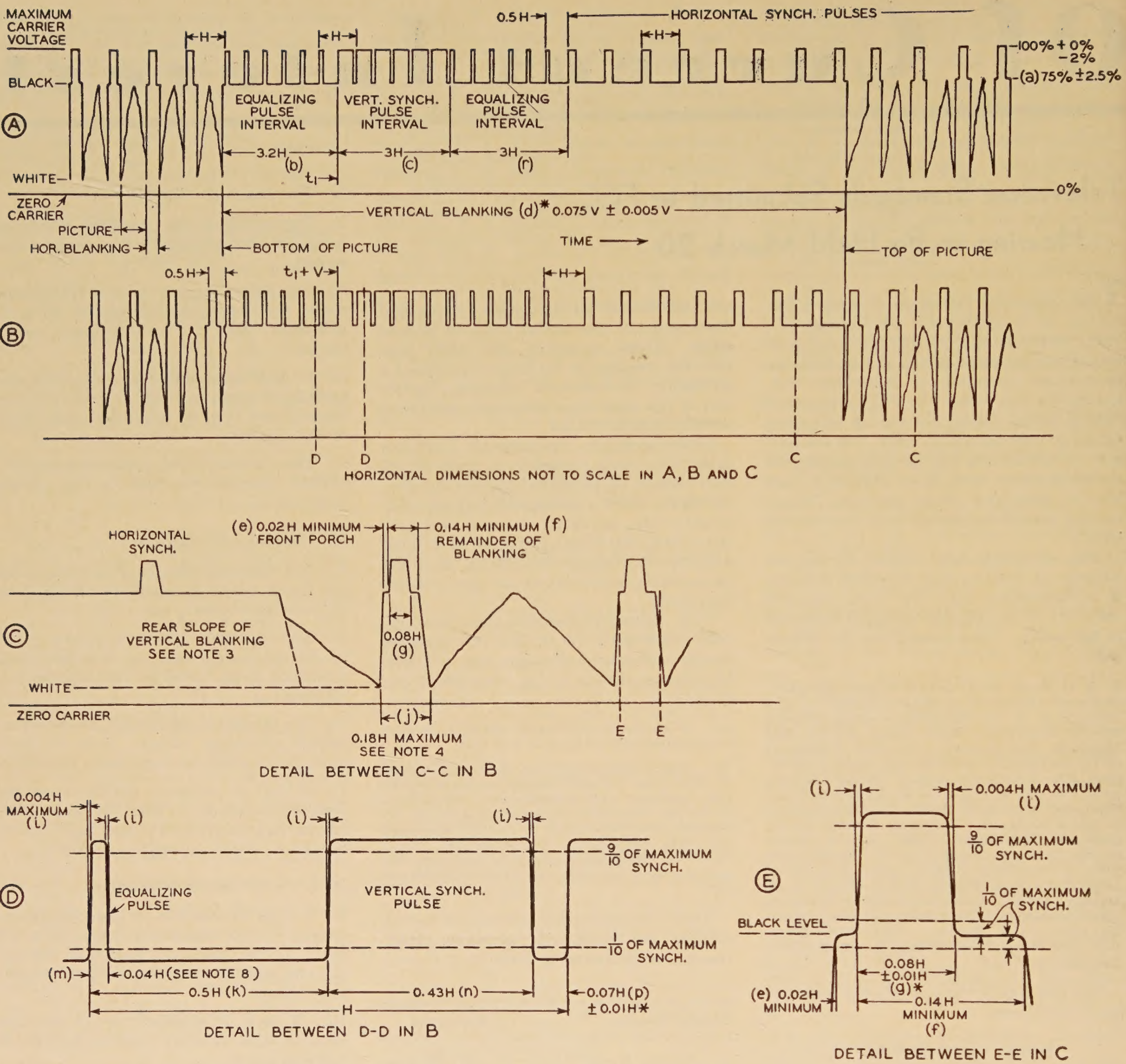


Figure 2. Television synchronizing wave form

1. H = time from start of one line to start of next line
2. V = time from start of one field to start of next field
3. Leading and trailing edges of vertical blanking should be complete in less than $0.1H$
4. Leading and trailing slopes of horizontal blanking must be steep enough to preserve minimum and maximum values $(e+f)$ and (h) under all conditions of picture content
5. There shall be no overshoot on front or rear slopes of any pulses
6. * Dimensions marked with an asterisk indicate that tolerances given are permitted only for long-time variations and not for successive cycles
7. For receiver design, vertical retrace shall be complete in $0.07V$
8. Equalizing pulse area shall be between 0.45 and 0.5 of the area of a horizontal synchronizing pulse

16. It shall be standard that the time interval between the leading edges of successive horizontal pulses shall vary less than 0.5 per cent of the average interval.

17. It shall be standard in television studio transmission that the rate of change of the frequency of recurrence of the leading edges of the horizontal synchronizing signals be not greater than 0.15 per cent per second, the frequency to be determined by an averaging process carried out over a period of not less than 20, nor more than 100, lines, such lines not to include any portion of the vertical blanking signal.*

VI: Transmitter Ratings

18. It shall be standard to rate the picture transmitter in terms of its peak power when transmitting a standard television signal.

19. It shall be standard in the modulation of the picture transmitter that the radio frequency signal amplitude be 15 per cent or less of the peak amplitude, for maximum white.†

20. It shall be standard to employ an unmodulated radiated carrier power of the sound transmission not less than 50 nor more than 100 per cent of the peak radiated power of the picture transmission.

21. It shall be standard in the modulation of the sound transmitter that the maximum

deviation shall be plus or minus 75 kilocycles per second.

VII: Polarization

22. It shall be standard in television broadcasting to radiate horizontally polarized waves.

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* It is recommended that as progress in the art makes it desirable the maximum rate of change of frequency of the transmitted horizontal synchronizing signals for studio programs be reduced and that limits be set for transmissions originating elsewhere than in the studio.

† It is the opinion of the NTSC that a picture transmitter not capable of a drop in radio frequency signal amplitude to 15 per cent or less of the peak amplitude would be unsatisfactory since it would not utilize to the best advantage the available radio frequency power. At the same time the NTSC is aware of the practical situation that it may not be possible for all of the first picture transmitters to meet this standard. It should be possible in picture transmitters for the lower frequency channels in Group A to meet this standard, although it may not be possible for picture transmitters for the higher frequency channels in Group A to meet it at first. After the first operation on the higher frequency channels and as designs progress it should be possible to meet it. It is requested that the Federal Communications Commission take cognizance of this situation.

Other Societies •

Alfred Noble Prize Not Awarded for 1940

No award of the Alfred Noble Prize will be made for 1940, according to recent announcement by the Alfred Noble Prize committee. Normally the prize, which was established in 1929 in memory of the late Alfred Noble, is awarded annually by a joint committee representing the American Society of Civil Engineers, American Society of Mechanical Engineers, AIEE, American Institute of Mining and Metallurgical Engineers, and Western Society of Engineers, for a technical paper of exceptional merit, by an author under 31 years of age. C. E. Shannon (A'39), Massachusetts Institute of Technology, won the 1939 award.

In its recent announcement, the committee describes the character of the prize and the considerations governing its award, as follows:

"The award consists in a certificate, a cash prize, amount dependent on income, which is now $350, plus an allowance for the traveling expenses of the recipient to the annual meeting of the society of which he is a member and at which the award is made.

"The Alfred Noble Prize is normally awarded annually for 'a technical paper of exceptional merit' which has been published during the year ending May 31 by one of the participating societies, provided that the author has not passed his 31st birthday at the time the paper is submitted for publication 'in practically its final form.'

"The prize committee has always attempted to interpret the term 'technical' in a liberal manner. The awards have gone both to papers of a largely descriptive type and to papers of a highly mathematical nature. It is deemed essential, however, that any descriptive paper should contain a sufficient amount of factual data, analysis, and detail to make it of more definite value to the profession than a simple news report. Similarly, no paper of the mathematical type is considered satisfactory if it offers no promise of practical application. The award is for a technical rather than a scientific paper, and practical values are a *sine qua non*.

"Needless to say, the paper must be an individual work of the author, must reflect originality. Presumably any author will make suitable acknowledgment in his paper for aid or suggestions received from his colleagues or superiors, and all papers are naturally subject to the usual editorial changes of the publisher. A joint paper, or one which does not reflect individual effort and initiative, is not, however, acceptable.

"A paper must be of 'exceptional merit.' The committee recognizes that the younger members in our national societies—both the young engineers in practice and the young men undertaking postgraduate work in an engineering school—have made and are making valuable contributions to the technical progress of the engineering profession. It is natural, however, that many of these contributions will consist of minor improvements in the detail of existing practice or similar extensions of present theory or technique. The committee must judge when such contributions are sufficiently outstanding as to indicate 'exceptional merit.' This is, of course, a difficult question, and in answering it the Committee endeavors to secure the advice of senior engineers who are experienced in the special field covered by the paper in question.

"It is also the view of the Committee that the paper should be of a character suitable for presentation at a meeting or for publication in the permanent technical records of the society, that is, proceedings or transactions. If the Noble Prize is to be maintained on a high plane of competition, it is inevitable that the burden of proof as to importance and exceptional merit must rest with the paper. Accordingly the committee, while attempting to keep its standards reasonable, must insist that 'exceptional merit' be clearly demonstrated.

"Papers are not 'entered' for the Alfred Noble Prize. Each year a list of *all* papers which meet the requirements as to publication, authorship, etc., are studied by an appropriate group within each of the participating societies. The paper recommended by the representative of each society on the Alfred Noble Prize committee is then considered by the committee and of the papers so submitted one is selected by this committee for the award, or no award is made."

ASA Provides for Defense Emergency Standards

The American Standards Association, in order to be prepared to act promptly on requests for the preparation of standards for use in the national defense program has adopted a temporary annex to its "Procedure". This annex, approved January 7, 1941, greatly abbreviates the normal procedure applying to the development and approval of standards in ASA. The provisions of the annex follow:

(*a*). Defense emergency standards, developed or adopted under the following abbreviated procedure, may be issued by the Association under authority of the Standards Council.

(*b*). Any request for the development or adoption of such a standard shall be referred to the chairman of the Standards Council. If in his opinion such a standard is urgently needed in the interest of national defense, he shall so declare and shall notify the Standards Council to that effect.

(*c*). The chairman of the Council, together with the chairman of the appropriate correlating committee or committees, shall act for the Council on the approval of a project, the scope of the project, the method of procedure to be used, and where a project committee is necessary shall appoint its personnel.

(*d*). In the case of standards drafted by the emergency technical committees, the draft shall be referred to a reasonable number of key individuals in the groups having a substantial concern with the subject of the standard, with the request that their comments be returned within a limited period of time. The emergency technical committee shall consider all such comments, and in submitting the revised draft for action by the appropriate correlating committee shall report what disposition has been made of the comments.

(*e*). The chairman of the Council shall act for the Council on the approval of a standard as a defense emergency standard, upon favorable recommendation of the correlating committee concerned, or the board of examination, but a 1/6 negative vote of a correlating committee, or one negative vote of the board of examination, shall prevent the issuance of any such standard.

(*f*). The members of the Standards Council and of the correlating committee concerned, shall be informed promptly of all requests for standards, and of proposed scopes, methods of procedure to be used, personnel of committees, and submittals of standards for approval.

(*g*). All such defense emergency standards shall be published in a distinctive uniform format. The words Defense Emergency shall appear in the title, e.g.,

American Defense Emergency Standard
Specifications for . . . .

(*h*). After the emergency shall have passed, the defense emergency standards will be immediately reviewed by the appropriate correlating committees, and approved, amended, or withdrawn, through the regular procedures of the Association.

Future Meetings of Other Societies

American Chemical Society. April 7–11, 1941, St. Louis, Mo.

American Institute of Chemical Engineers. Semiannual meeting, May 19–21, 1941, Chicago, Ill.

American Physical Society. 241st meeting, May 1–3, 1941, Washington, D. C.

American Railway Engineering Association. Annual meeting, March 11–13, 1941, Chicago, Ill.

American Society for Testing Materials. 44th annual meeting, June 23–27, 1941, Chicago, Ill.

American Society of Civil Engineers. Spring meeting, April 23–25, 1941, Baltimore, Md.

American Society of Mechanical Engineers. Spring meeting, March 31–April 3, 1941, Atlanta, Ga.

Semiannual meeting, June 16–20, 1941, Kansas City, Mo.

Edison Electric Institute. June 2–5, 1941, Buffalo, N. Y.

Electrochemical Society. Spring meeting, April 16–19, 1941, Cleveland, Ohio.

Illuminating Engineering Society. 2d annual lighting conference, April 25–26, 1941, San Francisco, Calif.

Midwest Power Conference. April 9–10, 1941, Chicago, Ill.

National Electrical Manufacturers Association. May 11–15, 1941, Hot Springs, Va.

Society of Automotive Engineers. National production meeting, May 12–13, 1941, Milwaukee, Wis.

Summer meeting, June 1–6, 1941, White Sulphur Springs, W. Va.

Letters to the Editor • • •

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

A Simple Method of Calculating Power Factor

To the Editor:

Mr. Graybeal's method of calculating power factor (*EE, Nov. '40, p. 480*) is correct and not too cumbersome, but he is not using his slide rule to the greatest advantage.

Practically every slide rule except the 25-cent rules—and an engineer who uses one of those ought to be ashamed of himself—has the sine and tangent scales. Why not put these scales to use?

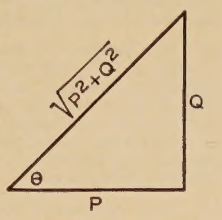

Figure 1

Consider the following analysis for determining power factor:

$$PF=\frac{P}{\sqrt{P^2+Q^2}}=\cos\theta$$

But

$$\theta=\tan^{-1} Q/P$$

Hence

$$PF=\cos(\tan^{-1} Q/P)$$

Therefore simply find the angle whose tangent is Q/P, and then find the cosine of that angle.

This method may not be shorter than Mr. Graybeal's but it certainly is no longer; it is more fundamental, and the decimal-point worry has been entirely eliminated.

Sanford Hershfield (Enrolled Student)

(Cooper Union Institute of Technology, New York, N. Y.)

A Simple Method of Calculating Power Factor

To the Editor:

In his letter on calculation of power factor (*EE, Nov. '40, p. 480*) Troy D. Graybeal has indicated a simple means of vector transformation on a small slide rule. However, because he did not specifically state this connection, and because as a student I know how many hours I have wasted in lengthy vector changes, I should like to draw attention to this very fast system. Perhaps I should mention that I first came across the method in *Civil Engineering*, December 1937. Although it seems general knowledge, no one has printed it for the benefit of us beginners.

Using the common rule with seven scales (A, B, C, D, and log, sin, tan on reverse of slide), the same procedure is followed in changing $a+jb$ to $A\underline{/\theta}$ by using form

$$a+jb=\sqrt{a^2+b^2}\ \underline{/\tan^{-1} b/a}$$

but in the first step the angle is read from the rear of the slide (taking care that the first fraction is of such magnitude that the correct angle is read, depending upon direction of the scales).

In going from $A\underline{/\theta}$ to $a+jb(=A\cos\theta+jA\sin\theta)$, A is set on A scale and the slide is moved to first sin $(90°-\theta^0)$ and later to sin $\theta°$. Thus $a+jb$ is found by reading a and b directly under the indicator on the B scale under A. The principle used is, of course, that $\cos\theta=\sin(90°-\theta^0)$.

These simple operations may prove helpful to those using vectors frequently. In the hope of simplifying the solution for cube root on these rules, I offer the following hint:

First divide or multiply by 1,000, 1,000,000, etc., so as to place result in range 1–1,000. For numbers 1–10 and 100–1,000 use left half of A scale and for those of 10–100 use right half. Use only left half of B scale for all ranges, with restriction of 1 to 2.15 for numbers 1–10, 2.15 to 4.64 for 10–100, and 4.64 to 10 for 100–1,000.

Simply set indicator on number on A scale as above and move slide until number on B scale directly beneath hairline coincides with number under index, on D scale, which number then is the cube root, remembering correct decimal place. The actual operations take but a few seconds.

Because of the number of student readers, myself included, I should like to petition for a small nook among the "letters" devoted to hints of short cuts in using the slide rule. There may be many timesavers now potent only in the minds of some old-timers.

William C. Urlovic (Enrolled Student)

(Electric department, Pacific Gas and Electric Company, San Francisco, Calif.)

Books Received •

"Temperature—Its Measurement and Control in Science and Industry". To make permanently available the valuable papers presented at a symposium on this subject sponsored by the American Institute of Physics with the co-operation of the National Bureau of Standards and the National Research Council, held last winter in New York (*EE Oct. '39, p. 437*) they have been collected in a 1,375-page volume. Also co-operating in the project were: American Ceramic Society, American Chemical Society, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Society for Metals, American Society of Heating and Ventilating Engineers, American Society of Refrigerating Engineers, American Society for Testing Materials, American Standards Association, American Welding Society, Society of Automotive Engineers, and American Foundrymen's Association.

The original papers have been carefully edited by authorities in their fields. They have also been rearranged, supplemented, and exhaustively indexed. All phases of temperature are covered in great detail. The material in the book is arranged in 13 chapters headed as follows: temperature and temperature scales; precision thermometry; education; natural sciences; temperature in biology; temperature and its regulation in man; automatic temperature regulation and recording; special applications and methods; general engineering; metals and ceramic industries; oil industries; optical and radiation pyrometry; and thermometric metals and alloys.

The book is expected to be especially valuable for chemists, teachers, physicists, biologists, medical men, metallurgists, geologists, electrical, mechanical and refrigerating engineers, and plant operating officials. By special arrangement, the book is published by the Reinhold Publishing Corporation, 330 West 42nd Street, New York City, list price $11.00 per copy. An appendix of 25 reference tables is included, which also may be purchased separately bound for $1.00 per copy.

"Men and Volts". Subtitled "The Story of General Electric", "Men and Volts" by John Winthrop Hammond tells of the development of the electrical era, from 1876 to 1940, in particular relation to the growth of the General Electric Company. The history as written by Hammond ends with the year 1922; to bring the record up to date an epilogue has been added, and the statement made by Owen D. Young to the Temporary National Economic Committee in 1939 included as an appendix. Published by J. B. Lippincott Company, Philadelphia, 1941; 436 pages, illustrated; price $2.50.

The following new books are among those recently received at the engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

COMMISSIONING OF ELECTRICAL PLANT AND ASSOCIATED PROBLEMS (Monographs on Electrical Engineering, volume V). By R. C. H. Richardson. Chapman and Hall, London, 1938. 363 pages, diagrams, etc., 9 by $5^1/_2$ inches, cloth, 24s. Aims to present general and specific information which has been found useful when putting into service both a-c and d-c generating, transforming, motive, and converting equipment. The preparation, likely troubles, and efficient testing of such equipment are fully described, and the last chapter outlines briefly several important conceptions useful in electrical-engineering calculations. There is a classified selected bibliography.

INDUSTRIAL MANAGEMENT. By R. H. Lansburgh and W. R. Spriegel. Third edition, John Wiley and Sons, New York, 1940. 666 pages, illustrated, 9 by 6 inches, cloth, $4.50. General organization technique is stressed in this discussion of the principles, problems, ideals, and successful methods of industrial management. In considering the plant, the product, personnel, wage payment, managerial controls, and operating procedures, an effort has been made to show the relationships of each major portion of a business to the others and to outside influences. Bibliography.

BILDWORT DEUTSCH TECHNISCHE SPRACHHEFTE 3. STARKSTROMTECHNIK. VDI-Verlag, Berlin, 1940. 36 pages, illustrated, $8^1/_2$ by 6 inches, paper, 1.50 rm.; to members, 1.35 rm. Power-current technology is the subject of this third in a series of pamphlets designed to help engineers to read German technical publications. Various related topics are described and labeled, and illustrative diagrams are included as vocabulary aids. Large subject index.